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ORIGINAL ARTICLES.

I.—Cave Hunting in Cyprus.

By Henry Woodward, LL.D., F.R.S., F.G.S.

FROM the days when Nimrod began to be "a mighty hunter before the Lord," down to those in which our friend Fred. C. Selous shot 'big game' in Africa, the hunter has always occupied a specially exalted position and enjoyed a much envied notoriety in all countries. But alas for the wild animals! they are now rapidly becoming exterminated by man, and their place on the prairie, the pampa, the veldt, and in the forest will soon know them no more.

Early in the last century, that enthusiastic geologist Dean Buckland invented a new sport, devoid of slaughter or destruction of life, yet full of the keenest interest for the zoologist and the geologist, namely, the hunting for wild animals in cave deposits. The *later* poet of Kent's Cavern wrote:—

> "Full many a tooth with cutting edges keen
> The virgin limestone caves of England bear;
> Full many a bone of elephant, I ween,
> Awaits the hunter who shall seek it there!"

After labouring in Kirkdale, the Mendips, the Gower Caves, and those of Germany, France, and Gibraltar, Buckland published his "Reliquiæ Diluvianæ" in 1823. Out of more than thirteen caves he records the discovery of remains of Hyæna, Tiger (*Machærodus*?), Bear, Wolf, Elephant, Rhinoceros, Hippopotamus, Wild Boar, Horse, Deer, *Bos*, sp., Beaver, and other animals of less interest.

Even at that early date he excited at least one enthusiastic contemporary, the Rev. J. McEnery, who explored 'Kent's Hole,' Torquay, and proved the contemporaneity of early man with the Sabre-toothed Tiger (*Machærodus*) and other extinct animals in this ossiferous deposit. But public opinion had not as yet been aroused to take an interest in the question of 'the antiquity of Man,' and more than thirty years elapsed before further investigations were made, supported by Lyell, Busk, Schmerling, Falconer, Evans, Lubbock, Pengelly, Lartet, and Christy, and later on by Boyd Dawkins, Tiddeman, Hicks, Hughes, and others, down to the many workers of the present day.

After all that has been published upon the subject, one would have expected that such investigations would have lost their interest with geologists and naturalists, and also with the public at large, but this is far from being the case.

So lately as January last, Professor Boyd Dawkins communicated to the Geological Society of London an account of the discovery in 1901–2 of an ossiferous cavern of *Pliocene* age at Doves Holes, Buxton, Derbyshire, which, besides containing *Machærodus*, *Hyæna*, *Elephas*, *Rhinoceros*, *Equus*, and *Cervus*, yielded numerous examples of *Mastodon arvernensis*, an animal well known from the Crag, but no cave in Europe has hitherto yielded such a Pliocene fauna!

In September, 1898, the fresh skin of a species of *Mylodon*, a ground-sloth (named *Neomylodon Listai*), was discovered in a cavern near Consuelo Cove, Last Hope Inlet, Patagonia. Other numerous discoveries from the same cave followed, from which it appeared that many examples of this great sloth had been imprisoned and fed by man, and ultimately killed and eaten there by an early race of Indians, who also ate the horse, the huanaco (*Auchenia*), the bear, puma, and other animals, and left their remains, and also their own bones and weapons, to testify to their presence in the cave contemporary with the *Mylodon*.

The long series of researches in caves and ossiferous deposits on the islands and seaboard of the Mediterranean begun more than fifty years ago, and continued down to the present day, by numerous English and foreign geologists,[1] has resulted in the accumulation of most important evidence relative to the Eocene, Miocene, Pliocene, and Pleistocene faunas of this region, particularly those of Gibraltar, Concud in Spain, Mt. Léberon in France, Olivola and the Val d'Arno in Italy, the caves of Malta and Sicily, the deposits of Pikermi and Eubœa in Greece, Samos (Asia Minor), Maragha (Persia), the Fayum (Egypt). The important discoveries of vertebrate faunas in the Egyptian Tertiaries have already been noticed in the pages of this Magazine.[2]

Having made previous acquaintance with cave-hunting, by the exploration of a bone-cave on the River Wye and the description of its mammalian contents (see Geol. Mag., 1901, Dec. IV, Vol. VIII, pp. 101–106, with 8 text-figures), Miss Dorothy M. A. Bate set forth in the Spring of 1901 to make an exploration of the caves, said to be numerous, in the long limestone range of hills forming the northern border of the Island of Cyprus; she also found similar ossiferous deposits at Cape Pyla on the south-east coast.

Early in 1902 Miss Bate sent home to Dr. C. I. Forsyth Major some much worn teeth about the size of a pig's molars, which

[1] We recall the names of Professor Gaudry, Admiral Spratt, Dr. Falconer, Professor Busk, Dr. Leith Adams, Dr. C. I. Forsyth Major, Dr. Pohlig, Mr. J. H. Cooke, Dr. A. S. Woodward, and Dr. C. W. Andrews.

[2] Geol. Mag., 1899, p. 481, Fossil Mammalia from Egypt; 1900, p. 1, *Podocnemis Ægyptiaca*; p. 401, Fossil Mammalia from Egypt; 1901, pp. 400 and 436, Vertebrates of Egypt; 1902, p. 291, Extinct Vertebrates of Egypt; p. 433, Pliocene Vertebrate Fauna of Wadi-Natrun; 1903, p. 225, Evolution of Proboscidea.

showed no indication of the trefoil pattern so characteristic of the molars of *Hippopotamus*. A second small parcel contained a few less worn teeth, together with a germ-tooth, from which it became at once evident that we had to do with a mammal of the Hippopotamus tribe, about half the size of a middle-sized *H. amphibius*, with molars exhibiting a modification of the common *Hippopotamus* pattern, approximating them to a less specialized type of Artiodactyle teeth. Dr. Forsyth Major's account of this discovery, from which we quote, was published in the Proceedings of the Zoological Society of London (June 3, 1902; pp. 107–112, plates ix and x) after the arrival of very numerous remains from Cyprus, obtained by Miss Dorothy Bate, and carefully developed in the British Museum (Natural History), Cromwell Road. In his description, the author compares the small *Hippopotamus* from Cyprus with the numerous remains of allied species preserved in the Museum from the other Mediterranean islands and from elsewhere. Dr. Forsyth Major had himself obtained and described a pigmy form from Madagascar (see GEOL. MAG., 1902, Dec. IV, Vol. IX, pp. 193–199, Plate XII); another is found living in Liberia, west coast of Africa, at the present day, though probably verging on extinction. The large *H. amphibius* has still a wide distribution on the great lakes and rivers of Africa, and was once abundant also in Europe and in this country; whilst *H. sivalensis* is met with fossil in the Siwalik Hills of India. The Maltese caves and Sicily have yielded abundant remains of the small *Hippopotamus Pentlandi*, and of a much smaller and very rare species from Malta formerly called *H. minutus*, but now known as *H. melitensis*; this is about one-fifth larger than that from Cyprus, and the pattern of the teeth in the Maltese form differs from that of Cyprus and agrees closely, except in size, with the living *H. amphibius*; they cannot, therefore, be referred to the same species.

Dr. Forsyth Major also compares the Cyprus *Hippopotamus* with one from the lignites of Casino (Tuscany), and also with one from the Wadi-Natrun, described by Dr. C. W. Andrews. They are larger in size than the Cypriote specimens and present other differences; the Casino specimen, in particular, being hexaprotodont in its dentition. Strange to say, a perfect counterpart both in shape and size to the Cyprus specimen is presented by Cuvier's "petit Hippopotame fossile" (*H. minutus*, Blainv.), a species of *Hippopotamus* which resembles in miniature the living hippopotamus, but which does not surpass the size of a pig, the locality of which was, alas! *unknown*, Cuvier having found the specimen in the basement of the Paris Museum without any label to record its origin. He afterwards received some identical remains from a private collection in Bordeaux, and from the Cabinet d'Histoire Naturelle of a M. Decken in Brussels. Whilst admitting the absolute identity of the Cyprus teeth collected by Miss Bate to-day with those described a hundred years ago (but *without a locality*) by Cuvier, Dr. Forsyth Major points out that in all stages of their growth they differ most specifically from the living *H. amphibius*. Cuvier's specimens

certainly did not come from Dax, and Dr. Forsyth Major concludes (after careful comparison) that they may have been brought from Cyprus. It is very interesting, archæologically, to find that at the end of the seventeenth century the ossiferous breccias at Chrysostomo, near Kythræa (Hagia Marina), in the district of Nicosia, where Miss Bate obtained some of her collection, were looked upon as sacred relics which the Greek inhabitants worshipped, and that these very bones of the pigmy hippopotamus were passed off upon the pious as those of their saints! and were thus accidentally introduced to the attention of Cuvier and De Blainville a hundred years ago!

A still more interesting discovery has rewarded Miss Dorothy Bate's labours in the bone-caves of Cyprus, namely, the discovery of a new species of pigmy elephant in the same ossiferous deposits which contained the pigmy *Hippopotamus minutus*. But we will allow Miss Bate to tell the story in her own words.[1]

"While still in Cyprus the receipt of a grant from the Royal Society in April, 1902, enabled me to devote a considerable amount of time not only to making more extensive excavations in some of the caves previously found, but also to a search for further cave deposits. I confined my attention chiefly to the Keryina range of limestone hills in the north of the island, in the hope of finding bone caves containing other remains than those of the pigmy *Hippopotamus*, of which Dr. Forsyth Major has already given a short description[2] from specimens discovered by myself.

"In this search I was at length successful, although it was not until a certain amount of tentative digging had been carried on in four out of five newly discovered deposits that work was started on what appeared at first to be the most unpromising looking place which had been found, and was consequently the last to receive attention.

"However, during the first day one of the workmen found, not far from the surface, part of a tooth which was at once recognised as being that of an elephant. After this discovery every effort was made to procure a complete collection of the remains of this species, but at no time were either teeth or bones found to be so plentiful as those of *Hippopotamus minutus*, with which they were associated.

"Often not a single proboscidean tooth would be obtained during two or three days' work, and only eleven molars and parts of molars were procured as the result of three weeks' digging. It was then decided to continue excavations here for a short while longer, and this was done until the end of July, work being again resumed in the beginning of the following October.

"Altogether a good series was obtained of the teeth of this elephant, which is found to be a pigmy species. With the exception of the first milk molar (m.m. 2), specimens were procured of all the milk

[1] "Preliminary Note on the Discovery of a Pigmy Elephant in the Pleistocene of Cyprus." By Dorothy M. A. Bate. Communicated by Henry Woodward, LL.D., F.R.S., F.G.S., V.P.Z.S., late Keeper of Geology, British Museum (Natural History). Read May 7, 1903. Proc. Roy. Soc., pp. 498–500.

[2] Proc. Zool. Soc., June 3, 1902.

and permanent molars of both the upper and lower jaws; also a number of tusks of different sizes, though these included none of the tiny milk incisors. No teeth which could be referred to very aged individuals were obtained, for amongst the last true molars none have more than half their full number of plates in use.

"The series of teeth consisting of specimens of very small size, it was natural in the first instance to compare them with the remains of the dwarf species from the Pleistocene deposits of the caves and fissures of Malta and Sicily. It was thought probable that they would differ from these, the fact of the pigmy hippopotamus of Cyprus being distinct from those found in the other large Mediterranean islands lending colour to the supposition; this expectation was fulfilled, for the Cyprus fossils do not appear to be identical with any of the Maltese species, though they seem to come nearest to *Elephas melitensis* both in size and in the number of plates in the molars. The number of these plates in any particular tooth is liable to vary to a certain extent, but on taking the average, as far as this can be judged from the amount of material available, the resulting ridge formula, exclusive of talons, is

$$\frac{5\ 7\text{–}8\ 8\ 9\ 12}{5\ 7\text{–}8\ 8\ 9\ 12}$$

which practically agrees with that of *E. melitensis* given by Dr. Falconer.[1]

"The teeth of the Cypriote elephant are considerably smaller than those of *E. mnaidriensis*, from both Sicily and Malta, this being the largest species from the last-named island. They also differ somewhat in their ridge formula, which is that mentioned above, while Dr. Leith Adams[2] gives that of *E. mnaidriensis* as

$$\frac{3\ 6\ 8\text{–}9\ 8\text{–}9\ 10\ 12\text{–}13}{3\ 6\ 8\text{–}9\ 8\text{–}9\ 10\ 12\text{–}13}$$

"The Cyprus form seems to have been also slightly inferior in size to *E. melitensis*, for its largest upper and lower molars do not equal, either in length or breadth, some of the specimens of the corresponding teeth of this Maltese species which are in the collection of the British Museum. Its tusks differ from all those from Malta in being compressed laterally, which character is especially noticeable in those of the female and young; further, they appear to be more strongly curved than those of *E. melitensis*.

"As a general feature it may be said that the molars from Cyprus are, on the whole, more simply constructed than those of *E. melitensis*. They show a still slighter tendency to 'crimping' in the bands of enamel, and are less inclined to develop the mesial expansion of the plates of dentine which is not uncommonly found in the teeth of *E. melitensis*, and is so conspicuous in those of *E. Africanus*.

"It is well known that when the plates of an elephant's tooth first

[1] Pal. Mem., vol. ii, p. 298; London, 1868.
[2] Zool. Soc. Trans., vol. ix (1874), p. 112.

come into use, the edging of enamel is in the form of a series of rings owing to the digitation of the plates. These are later worn into a single band surrounding the enclosed area of dentine.

"In the Maltese specimens it is not uncommon to find the encircling enamel persisting thus divided for a considerable time. Even four or five ridges may remain in this condition at one time in a single tooth, with perhaps an anteriorly decreasing number of rings. This is well shown in a tooth, now in the British Museum collection, doubtfully ascribed by Mr. Busk[1] to the first upper true molar of *E. Falconeri*. This is not so much the case in the Cyprus specimens, in which the bands of enamel only remain thus separated into several annuli for a very short while after the plate comes into wear.

"The molars vary considerably, some specimens having very broad crowns, while others are somewhat narrow. The bands of cement are wide, in perhaps the majority of cases almost, or quite, equalling in width the plates of dentine; this seems to be the exception and not the rule in the molars of *E. melitensis*.

"Taking into consideration the several characters in which the teeth of the Cyprus elephant differ from those of all the hitherto described dwarf species (putting on one side *E. lamarmoræ*[2] from the Pleistocene of Sardinia, the teeth of which are unknown to science) as well as the distinct habitat of the animal, I have come to the conclusion that it is specifically distinct from these other small forms, though possibly they were derived from a common ancestor, and I therefore propose to name it *Elephas cypriotes*.

"The discovery of the remains of this pigmy elephant, as well as of *Hippopotamus minutus*, in Cyprus, is interesting in comparison with the dwarf species from Malta and Sicily, and because the presence of an extinct mammalian fauna in this locality had not previously been recorded. The occurrence of these different, though apparently closely related, races of small elephants in widely separated islands of the Mediterranean, lends probability to the theory that this is a case of independent development along similar lines, the result of similar circumstances and environments. Nevertheless, it would perhaps be wise not to take it for granted, without further evidence, that this diminutive size is wholly and entirely due to specialisation." (Proc. Royal Society, May 7, 1903, pp. 498–500.)

Miss Dorothy Bate hopes to be able to communicate a more detailed account, with figures and full descriptions, of the collection of elephant remains from Cyprus. We also learn that she will shortly read a note upon a new species of extinct Genet from Cyprus at the Zoological Society of London.

It is to be hoped that this is but the commencement of a very successful scientific career for the author, who has evidently given her best energies to this most interesting and attractive line of investigation.

[1] Zool. Soc. Trans., vol. vi, p. 295, pl. liii, fig. 9.
[2] Dr. Forsyth Major, "Die Tyrrhenis": *Kosmos*, vol. vii (1883), p. 7.

II.—A New Carboniferous Arachnid.

By R. I. Pocock, F.Z.S., of the British Museum (Natural History).

Introductory Remarks.

LAST April Dr. Anton Frič, of Prague, applied to the Natural History Museum for the loan of a fossil Arachnid which he had seen during a short visit to London in the Summer of 1902, and wished to include in a descriptive monograph of Carboniferous Arachnida which he has now in preparation. Since the specimen is unique, it was unfortunately impossible to accede to the request. Dr. Smith Woodward, however, kindly suggested that I should examine the specimen and, if necessary, describe and figure it, so that perchance an account of it might yet be in time to find a place in the monograph above referred to. The specimen, imbedded in the two pieces of a split nodule of clay-ironstone from the Carboniferous measures at Coseley, near Dudley, belonged formerly to the collection of Mr. Henry Johnson. It bears the register number 1551, and is ticketed by Dr. H. Woodward "*Eophrynus*, sp. nov." The dorsal surface is exposed, part of it adhering to one face of the matrix, part to the other.

1.—*Description of the Specimen; its generic and specific features.*

The *carapace* unfortunately is crushed, and nothing positive can be affirmed as to its structure save that it appears to have been slightly wider than long, with a shallow, postero-lateral constriction and a straight, transverse, posterior border. In the middle line behind, however, there is an acutely angular impression, obviously representing the median impression occupying the same position and presenting much the same form in *Eophrynus prestvicii*, H. Woodw.[1] The crushed condition of the carapace suggests that its median area was axially elevated as in the last-mentioned species and in *Kreischeria wiedei*.[2] Had it been flat or but slightly convex as in *Anthracomartus*, the details of its structure would have been preserved, if we may judge from the state of preservation of the relatively depressed abdominal area. It is justifiable, therefore, to conclude that the carapace was constructed essentially as in *Eophrynus* and *Kreischeria*, approaching in particular that of the former in the smallness of the posterior flattened area and the shortness of the median muscular impression. It was, however, less expanded at its postero-lateral angles, and occupied in this respect a stage of development midway between that presented by the carapaces of these two genera.

The *appendages* show no new morphological features. None of them are complete. Of the first and second pairs nothing is left but undecipherable fragments. On the right side three of the legs, which, from their position, I judge to be the first, second, and fourth, are fairly well preserved. The basal segments (coxa and trochanter) are

[1] See H. Woodward, Geol. Mag., 1871, pp. 386–388, Pl. XI, and R. I. Pocock, Geol. Mag., 1902, p. 490, Fig. 1, A.

[2] See Haase: Zeitschr. deutsch. geol. Ges., xlii (1890), pl. xxx, fig. 6.

very vaguely defined, but the femur, patella, tibia, and protarsus of the first and second pairs can be easily made out. They resemble those of *Eophrynus prestvicii* in being grooved, but are hardly noticeably pitted. In the fourth leg the femur, patella, and most of

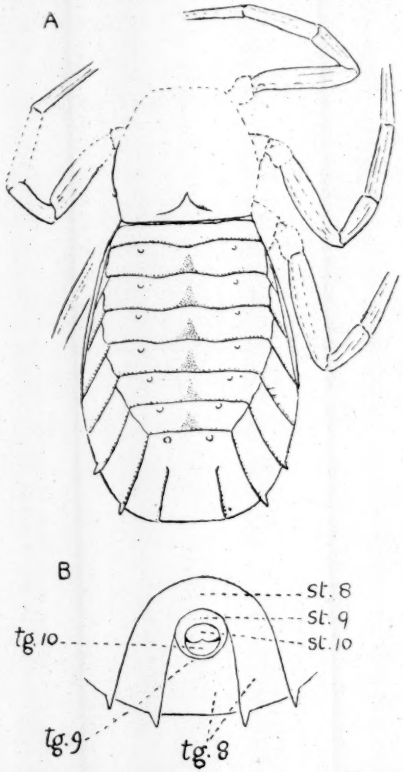

Fig. A.—*Anthracosiro woodwardi*, gen. et sp. nov. × about $2\frac{2}{3}$. The lateral laminæ on the second, third, and fourth abdominal segments are relatively larger than seen in the specimen, and the angular projection of the tergal plates abutting against the antecedent laminæ a little too far back.

Fig. B.—Emended figure of the posterior extremity of the ventral area of *Eophrynus prestvicii*, showing the division of the anal tubercle into a tergal (*tg.* 10) and sternal (*st.* 10) element; *tg.* 9 and *st.* 9, tergal and sternal area of annuliform preanal somite; *st.* 8, sternal area of eighth somite; *tg.* 8, median and lateral lamina of the dorsal area of the same.

the tibia are shown.[1] On the left side part of the femur of the fourth projects from beneath the abdomen, and half the femur, the patella, and the greater part of the protarsus of the second are likewise visible.

From the width of the carapace and the extent to which the basal segments of the appendages are left uncovered by its lateral borders,

[1] This appendage lies in a more vertical plane than the others, being thrust back partly over the abdomen. In the annexed figure what is to be seen of it has been drawn in a horizontal plane so that the structure of the abdomen is not concealed.

it may be inferred that the sternal area of the cephalothorax (prosoma) was wide, as in *Eophrynus*.

The *opisthosoma* (*abdomen*) shows very distinctly eight, and only eight, plates on its upper side. It thus resembles this region in *Kreischeria wiedei*, and differs from that of *Eophrynus prestvicii*, where nine plates are exposed, the first and second being short and apparently representing conjointly the first that is retained in *Kreischeria wiedei* and in the species now under notice. In the latter the first is the shortest of the series, the second the longest. The posterior border of the first is slightly convex in the middle; that of the others is fairly straight from side to side, although on account of a distinct and gradual elevation of the median area of the second, third, and fourth, this border appears from a superficial examination to be slightly concave in the middle. In the comparative straightness of the hinder border of the posterior terga, this species differs strikingly not only from *Eophrynus* and *Kreischeria*, but also from *Brachypyge* and *Anthracomartus*, in all of which the terga become progressively more and more recurved towards the posterior extremity of the abdomen. In the middle of the terga there is a distinct triangular granular area, wider behind than in front; there is also a series of fine granules defining the divisional lines between the terga and their laminæ; but the tubercles, which form so conspicuous a feature on the terga and lateral laminæ both of *Eophrynus* and *Kreischeria*, are here represented by a single pair of small tubercles upon the terga, and these are scarcely discernible on the anterior segments. The lateral borders of the third, fourth, fifth, and sixth terga are slightly produced anteriorly, and come into contact with the proximal extremity of the posterior side of the lamina of the antecedent segments. The lateral laminæ, too, are very different from those of the genera of Anthracomarti hitherto described. None are visible upon the first; on the second they appear as slender sclerites lying obliquely backwards; on the third and fourth they are of the same form, but larger, and project back in the same way, and their external margins are bordered by a strip of chitinous integument belonging to the lateral or ventral area of the body. It is not until the fifth segment is reached that the laminæ are at all comparable in development to those of other genera. From the fifth backwards they are large but fairly normal in size and form, their outer edges forming an evenly continuous curve. The posterior angles of the laminæ of the sixth and seventh segments, not of the seventh and eighth as in *Eophrynus* and *Kreischeria*, seem to be furnished with a spiniform process; but upon this point it would be rash to make a positive statement. The eighth segment is large, and furnished with the normal median and the two lateral laminæ separated by a deep groove; the lateral laminæ, however, are not marked off from the median area of the tergum, as is the case in most other Anthracomarti known. Owing to the small size of the anterior laminæ and the large size and obliquely backward direction of those at the posterior end of the abdomen, this region of the body is much longer in proportion to its width than in most Anthracomarti. The impression of the circular anal plate, omitted

from the drawing, is plainly visible through the eighth segment, near its anterior border.

The principal measurements in millimetres of the type-specimen are as follows:—Total length 21, length of carapace 6, width 7 (approx.); length of abdomen 15; greatest width 10; width in front 6·5.

The characters enumerated above, though proving incontestably the right of the species to a place amongst the Anthracomarti near *Eophrynus* and *Kreischeria*, show no less clearly the impossibility of associating it with either of these genera. And since it is not intermediate between these or any two genera known, but differs strikingly from all in certain well-marked features, it becomes necessary to erect a new genus for its reception. This I propose to name and diagnose as follows:—

Gen. Anthracosiro, nov.

Carapace and appendages of *prosoma* constructed apparently as in *Eophrynus*, having the posterior horizontal area and the median impression short. *Opisthosoma* consisting of eight tergal plates on its upper surface, as in *Kreischeria*, but the anterior and posterior border of all the plates transverse and subparallel, and not becoming progressively more and more recurved towards the hinder end of the body, as in *Eophrynus*, *Kreischeria*, etc. All the lateral laminæ directed obliquely outwards and backwards: those of the anterior segments in the form of narrow sclerites, overlapped externally by the chitinised subjacent integument; those of the posterior segments large. In *Kreischeria* and *Eophrynus* all the laminæ are large and subsimilar in size and shape.

The generic name for this Arachnid is suggested by the geological formation in which the fossil was found, and by its affinity, remote though it be, to the existing Opilionid genus *Siro*.

The typical and only known species of this genus I propose to name *Anthracosiro woodwardi*, sp.n., dedicating it to Dr. Henry Woodward, F.R.S., as a slight tribute to his valuable contributions to our knowledge of fossil Arthropoda. The specific characters of this species are enumerated with sufficient detail in the description of the specimen already given.

2. *Further remarks upon the morphology of the Anthracomarti.*

While working out this new Arachnid, I examined a cast of *Eophrynus prestvicii*, which I did not see previous to the publication of the description of this fossil in the Geological Magazine for October and November of last year. In this cast I notice one little structural point, of some morphological importance, which was not sufficiently defined in the others to allow me to speak with assurance about it. With reference to the anal plate, I said (p. 447): "This plate has the form of a transversely oval tubercle, and in one of the casts is marked by an incomplete transverse groove which suggests the possibility of its consisting of distinct sternal and tergal elements. If this be the case, the anal somite will resemble that of the Amblypygous Pedipalpi [Phrynidæ], rather than that of the Cyphophthalmous Opiliones." This groove is so strongly defined in the new

cast that I see no escape from the conclusion that it represents the anal orifice. Hence the anal somite is complete with respect to its tergal and sternal elements. In *Eophrynus*, therefore, eleven terga and ten sterna can be made out in the opisthosoma. The first tergal plate, which has no sternal representative, I homologised with the tergum of the pregenital somite, and the second, with the corresponding first sternal plate, with the tergum and sternum of the genital somite in *Phrynus* or the Pseudoscorpiones. A subsequent study of the Opiliones, however, has suggested an alternative interpretation of these plates which divorces *Eophrynus* from the Pedipalpi and brings it more into touch with the members of the former order, with which the structure of the appendages of the prosoma and of the segments of the opisthosoma forcibly suggests the Anthracomarti to be nearly related. In *Kreischeria*, *Brachypyge*, and *Anthracomartus*, for instance, only ten terga and nine sterna seem to be distinguishable in the opisthosoma, the difference in the number of segments in this region between these genera and *Eophrynus* being attributable to the disappearance, either by fusion or excalation, of the first tergal and the last sternal plates that are traceable in the latter genus. And when it is remembered that ten terga and nine sterna are also found in the opisthosoma in the Cyphophthalmous Opiliones, that the tergum of the eighth forms the posterior extremity of the dorsal surface, and overlaps that of the ninth, which, with its corresponding sternum, is reduced to an annuliform preanal sclerite, and that the tenth or last tergal plate has no sternal equivalent, but closes like a valve over the anus and is encircled in the way just described, exactly as occurs apparently in *Anthracomartus* and *Brachypyge*, it is difficult to doubt that the segments of the opisthosoma correspond each to each in the Cyphophthalmi and the genera of Anthracomarti just mentioned. If this be so, the first tergum and the first sternum in *Anthracomartus*, *Kreischeria*, and *Brachypyge* will correspond to the tergum and sternum of the first post-genital somite in *Phrynus*. In that case the genital aperture in the Anthracomarti must have opened in front of the first sternum, as it does in the Opiliones, and not behind it as I assumed in my former paper. *Eophrynus* is peculiarly interesting in this connection because it appears to be the only known genus of Anthracomarti that has retained an unmistakeable trace of the genital somite, unless the suggestion that I made with regard to the first tergal plate in *Anthracomartus völkelianus* and *Kreischeria wiedei* be correct.

In view of this new reading of the facts, the explanation of Fig. 1, A, p. 490, of my previous paper may be emended as follows:—The plate marked *pregen. tg.* will be the tergum of the genital somite, and the plate marked 1 *tg.* (*gen.*) that of the first post-genital somite.

This view of the matter was briefly alluded to in my paper upon the classification of the Opiliones,[1] and coincides with the explanation of the morphology of *Leptopsalis*, one of the genera of Cyphophthalmi, put forward by Börner six months earlier.[2]

[1] Ann. Mag. Nat. Hist. (7), x, pp. 504–515, December, 1902.
[2] Zool. Anz., June, 1902.

III.—The Purbeck Beds of the Vale of Wardour.

By A. J. Jukes-Browne, B.A., F.G.S.

THE paper written by the Rev. W. R. Andrews and myself, published in 1894, gave a more complete account of these beds than had previously been attempted; we showed that they were divisible into Lower, Middle, and Upper groups, comparable with those established by Professor E. Forbes in the Purbecks of Dorset, and characterized by the same species of Cyprides. This paper was based on the joint examination of exposures visible in 1890, though one of us, being then resident at Teffont, had observed and collected from these exposures for many years.

In the following year (1895) Mr. H. B. Woodward's memoir on the "Middle and Upper Oolitic Rocks" was published, and his account differed from ours in several particulars, notably as regards the thickness of beds referable to the three several divisions, as to the interpretation of the section near Dinton Station, and as to the total thickness of the formation. We refrained from comment at the time, partly because we were prepared to accept such corrections as were based on the freshly cut exposure near Dinton, and partly because the mapping of the district had not then been completed, and we were content to wait till this was done, in the expectation that Mr. Woodward would then reconsider some of the points on which we were not in agreement with him.

The mapping of the area was completed in 1900 by Mr. C. Reid, and this year (1903) the map (Sheet 298, new series), together with an explanatory memoir prepared by Mr. Reid, have been published. I am sorry to find, however, that the account of the Purbeck Beds in this explanation is merely a reprint of that given by Mr. Woodward in 1895, without any alteration, and with only some small additions by Mr. Reid. As the Geological Survey has failed to take advantage of this opportunity for revision, and as silence on our part might be understood as an admission that no such revision was necessary, I think it desirable to discuss some of the points in which our account differs from that given by Mr. Woodward. On some of these questions Mr. Andrews and I are disposed to modify the opinions expressed in 1894, but on others we continue to think that our views and observations are correct. We regret that it has not been possible for all concerned to meet on the ground, for we think that if this could have been arranged we should have come to an agreement on most, if not on all, the points of difference.

1. *The Section at Wockley.* — Mr. Woodward's account of this section is so different from ours that it is not easy to correlate the one with the other; but one point is clear, that he does not take the same plane of division between the Portland and Purbeck Series as we did. In this matter I am obliged to maintain that our account of the succession is not only fuller but more accurate than Mr. Woodward's, for he has not sufficiently distinguished between

the several beds at and near the junction of the two formations. That this is so will be apparent when the two descriptions are placed side by side (as below), but in order to indicate the correlative beds more clearly I have taken the details of the Portlandian part of the section from my notebook, in which the separation of the beds composing this series was fully noted.

Our account.	ft.	in.	*Mr. Woodward's account.*	
6. Laminated brown and grey clay, with patches of black clay	0	4	Dark shaly clay, much squeezed up in places.	
5. Hard whitish chalky limestone with Cyprids, and a layer of cherty stone with small lenticles of flint at the top	1	3	Compact limestones, 2 feet.	
4. Soft grey and white laminated marl ...	0	6		
3. Hard flaggy limestone with black flints at the top, passing down into chalky and shelly limestone	2	3	Bed of Roach, with lenticular mass of chert at top.	10 to 15 feet.
2. Rubbly chalky limestone full of large Pectens, with marked planes at top and at base	1	0		
1. Chalky limestone with Portland fossils	13	0	Chalky limestones, obliquely bedded, with Portland fossils.	

Bed No. 3 of the above succession is made up of two parts: the lower foot is a fairly compact, white chalky limestone, crowded with the shells of *Pecten lamellosus*; the upper part is a flaggy limestone without marine shells, but containing the Cyprides *Candona ansata* and *C. bononiensis*, which are marine and estuarine species: these two beds are closely welded together, they project beyond the others and usually break away in one block. Mr. Woodward follows Fitton and others (who considered the flaggy stone to be a fresh-water bed), and takes the plane along which they can be separated as the line of division between the Portland and Purbeck Series. We, having Professor Rupert Jones' assistance in determining the Cyprides, recognized the flaggy bed as of estuarine origin, and finding a marked plane at its summit, preferred to regard it as the topmost bed of the Portland Series.

I am quite prepared to admit that the beds which are welded together do contrast strongly in lithological character, and if this same kind of junction prevailed throughout the district, it would be a matter of small importance whether the one plane or the other were taken as the division between the two formations. It is well known, however, that in the Chilmark quarries (only two miles distant) there is a completely different development of beds at this horizon; at that place there are 16 feet of oolitic limestones between the top of the chalky limestone and the bed which is taken as the base of the Purbeck Series. I have suggested that the flaggy part of the 'junction bed' at Wockley is a reduced representative of these oolitic limestones, for if it is not so, then it is certain that these limestones can have nothing to represent them at Wockley, and in that case one would have expected to find a very well-marked plane of division between the Portland 'chalk' and the base of the Purbeck Beds.

Mr. Woodward rejects our view with the remark that, "to be consistent, however, we must continue to regard the old plane of division as the best, and going again to the district with Mr. Strahan no difficulty was found in determining this junction in the quarries near Tisbury and Chilmark." This strikes me as an extraordinary statement, for I cannot see where consistency comes in, and it is quite impossible to determine the same junction at Wockley and at Chilmark.

In all such cases where difference of opinion can arise, unless the main facts and features of the exposure are fully described, and unless the thickness of each separate bed is given, with a record of such fossils as come to hand, students who cannot visit the locality themselves are unable to form anything like a correct picture of the section. With this object we give in the Figure a diagrammatic representation of that portion of the quarry-face which includes the beds above mentioned.

ft. in.
Section at Wockley.
Base of confused beds.
0 4
Brown and dark grey clay.
1 3
Hard whitish limestone with Cyprides.
0 6
White laminated marl.
Hard flaggy limestone with black flints at top, Candona, etc., welded on to the top of
2 3
Chalky limestone, full of the shells of Pecten lamellosus.
Parting.
1 0
Rubbly chalky limestone, with Pecten lamellosus.
Parting.
13 0
Chalk of usual type with fossils, but no flints.

2. *Division of Lower and Middle Purbecks.*—The best exposure of this junction is in the quarry at Teffont, and of this section a full account was given by Mr. Andrews and myself, for he had watched it for many years and had obtained many fossils from the different beds therein exposed. We found *Cypridea fasciculata* (var. of *granulosa*) abundant in the 'flagstone bed' and in the shale above that bed, while in the clay below it was less abundant and was associated with *C. purbeckensis*. This clay-bed may therefore be taken as the junction of the two groups, and it would not matter whether it were included in the one or the other. Mr. Woodward, however, includes the flagstone and some of the overlying beds in the Lower Purbeck, putting the plane of division at the base of the calcareous shale or shaly limestone, which is full of a small *Modiola*.

Mr. Woodward gives no reason for his grouping of the beds; he does not dispute our record of *C. fasciculata*, though he does not quote it, and here, therefore, the question of consistency certainly does arise, for the accepted divisions of the Purbeck Series are based on the successive appearance and prevalence of the three species of *Cypridea*, *C. purbeckensis*, *C. granulosa*, and *C. punctata*, and any writer who accepts this basis of classification should be consistent and should not group beds as Lower Purbeck when their prevalent Cyprid is *C. granulosa*.

If Mr. Woodward preferred to adopt some other criterion he might have explained his reason for abandoning that of the Cyprides; it may be only a coincidence that his Lower Purbecks include all the so-called 'Lias beds,' but it is conceivable that he preferred to group together beds of similar lithological character rather than be fettered by the range of a single small Crustacean. In that case, however, "to be consistent" he should have made a similar alteration in the grouping of the Lower and Middle Purbecks of Dorset; it is not satisfactory to have one method of classification for Dorset and another for Wiltshire.

I see no reason for any departure from Forbes' convenient method, and consequently I maintain that the Middle Purbeck group in the Vale of Wardour is much thicker than Mr. Woodward makes it. In his table on p. 267 he gives the thickness of Middle Purbeck Beds as only 12 feet, but he has apparently based this estimate on his section of the railway-cuttings west of Dinton given on p. 274. In this section he has referred the lowest beds exposed to the Lower Purbeck, but I believe he is quite mistaken in such a correlation. His 'brown sandy limestone' No. 1 represents the 'shaly limestone,' which he takes as the base of the Middle Purbeck in Teffont quarry, and the whitish limestones above are the equivalent of the 'White Bed' in that quarry. I write confidently of this because there are similar beds in the next cutting on the railway (south of Teffont), and their combined thickness there (4 feet) is rather more than the beds on the same horizon west of Dinton (where Mr. Woodward's measurement makes them 3 feet 9 inches).

With the above correction, Mr. Woodward's restricted Middle Purbeck would be about 15 feet thick, but when the group is carried down to the base of the shale below the 'flagstone' in the Teffont quarry, as I consider it ought to be, its total thickness is a little over 22 feet.[1]

3. *The Upper Purbeck Group.*—The existence of this group in the Vale of Wardour was denied until the publication of our paper in 1894, though the Dinton cutting, in which the lower part of the group is exposed, had been open for many years, and if anyone had taken the trouble to collect Cyprides from the beds and to submit them to an expert like Professor Rupert Jones, he would have

[1] I admit an error in our computations of thickness on p. 66 of Quart. Journ. Geol. Soc., vol. L, due to our having counted in twice beds which we now recognize to be the same.

learnt that they contain plenty of *Cypridea punctata* without any *C. granulosa*.

In 1890 this cutting was partially grassed over, and the relations of the beds seen in it to those in the next cutting were not clear. The publication of our account induced Mr. Woodward to visit the place again, and he was fortunate enough to find that the cutting had been freshly widened so that the succession could be clearly seen; further, by digging below the level of the rails, he carried his measurements down to the *Archæoniscus* bed. Some of these beds were admitted by Mr. Woodward to be of Upper Purbeck age, but the greater part of what we had regarded as Upper Purbeck was referred by him to the Wealden.

With respect to the beds seen in the cutting, I accept the fresh evidence obtained by him: I agree with him as to the plane of division between the Middle and Upper Purbeck groups, and admit that there is no necessity for the hypothetical faults which we had introduced. I have no reason to doubt his measurements of the beds in the middle of the anticline, but think that the sand and clay at the base of the Upper Purbecks must thicken to the westward. Some of the sand which I saw at the eastern end of the second cutting may have been rearranged, but I do not think there was less than 6 feet of it *in situ*, or less than 4 feet of the clay below. This view is confirmed by the section in the deep cutting south of Teffont (not described by Mr. Woodward); we gave a complete account of the beds therein exposed, and it is now quite clear that they include the base of the Upper Purbeck. The highest beds seen are as follows:—

	ft.	in.
Wet grey and yellow sand	3 or 4	0
Light-grey sticky clay	1	8
Soft marly clays with thin brown iron-stained layers ...	2	0
Light buff-coloured marl	0	4
Hard whitish grey-hearted silty limestone	1	0

The limestone is clearly the same as that taken at the top of the Middle Purbeck in the Dinton cutting, and there is here 4 feet of marl and clay above it, succeeded by more than that thickness of sand. Mr. Andrews and I also saw the same limestone in the next cutting (south-east of Chicksgrove Farm), overlain by grey and yellow clay, brown sand and sandstone, and a gravelly soil, but these upper beds were confused by slipping; they are clearly a remnant of the outlier of Upper Purbeck subsequently mapped by Mr. Reid north-west of the Farm.

The basal part of the Upper Purbeck group being now established, there remains the question of its upper limit, and this we admit to be difficult of settlement. Mr. Woodward draws the line between Purbeck and Wealden, quite arbitrarily, at a thin layer of sand seen in the cutting about 10 feet below the surface of the ground. Of the beds thus referred to the Wealden Mr. Reid remarks, "In the Dinton cutting only some ten feet of the lower part of the Wealden Beds can be examined, and the exact age of these deposits is perhaps not quite satisfactorily made out." He thus admits that their age

is a matter of opinion, and I can understand that as he and Mr. Woodward were obliged to draw a line somewhere for delineation on the map of the Geological Survey they gave the Wealden the benefit of the doubt.

Mr. Andrews and I considered these beds as a continuation of the Upper Purbeck, and we obtained fossils from the material thrown out of a well sunk at the cottages near Dinton Station; it is true that most of the species found range from Purbeck to Wealden, but they included *Cypridea punctata*, which has not yet been recorded from Wealden. The well is 40 feet deep, and the fossils probably came from less than 30 feet down. How much of this thickness is Purbeck and how much Wealden is evidently a matter of opinion and extremely uncertain. The following may be given as a summary of the beds which lie between the Lower Greensand and the Middle Purbeck, near Dinton, with estimated thicknesses:—

	feet.
4. Yellow and grey silty clays by Dallwood Farm ...	15–20
3. Grey silty marl (in the well)	10–12
2. Stiff grey and yellow clays (in the well and cutting)...	25
1. Marls, shales, and grits (in the cutting)	12

No. 1 is Upper Purbeck; No. 2 may be either Purbeck or Wealden; Nos. 3 and 4 are probably Wealden.

4. *Purbeck and Wealden at Teffont.*—When in 1890 Mr. Andrews and I endeavoured to trace the Upper Purbeck and Wealden clays towards Teffont we found that their thickness became very much less, and that the space occupied by their outcrop north of Teffont Rectory was very narrow. We found there exposures of the following beds in descending order:—

D. Black clay.
C. Greenish-black glauconitic sand.
B. Mottled clay, white, yellow, and claret-coloured, like the 'cat's-brain' clay of Kentish Wealden.
A. Yellow silty clays.

The upper two members of this succession we regarded as Lower Greensand (Vectian), the lower two as Wealden, believing A to be part of the Dallwood Farm beds, No. 4 of the series near Dinton. We saw nothing between this and the Middle Purbecks, and there did not seem room for the Upper Purbecks (Nos. 1 and 2) to come in, so that we concluded the Wealden had here overlapped the Upper Purbeck Beds.

From the newly issued 1 inch map I find that Mr. Reid does not carry the Wealden clays so far west as the point where we saw the above succession, but has coloured all the beds north of the Rectory between the Middle Purbeck and the Vectian Sands as Upper Purbeck. It is clear, therefore, that Mr. Reid agrees with us in thinking there is not room enough here for the whole thickness of Upper Purbeck and Wealden, but differs from us in regarding the beds which do occur as Purbeck instead of Wealden. In the explanation of the map (Sheet 298) he does not describe any exposure of these beds north of Teffont, either under the head of Purbeck or Wealden, but quotes our description of them in his

chapter on the Lower Greensand, and then remarks that he doubts our correlation of the clays at Dinton and Teffont.

Here, again, therefore, it is a matter of opinion, and those responsible for the published mapping of this bit of ground do not seem able to give very good reasons for their beliefs. We suppose Mr. Reid correlates the yellow silty clay of Teffont with the yellow grey and white clays at the top of the Dinton cutting, but in the latter place there is nothing like the peculiar 'cat's-brain' clay, and until some one can find that kind of clay in the Upper Purbeck of the Vale of Wardour I shall continue to regard it as belonging to the Wealden, and to believe that Mr. Reid has not carried the Wealden far enough to the westward along the northern side of the Vale.

When describing the Purbeck Beds in 1894 we incidentally remarked that there was a complete discordance between the Purbeck Beds and the Lower Cretaceous Series, "including the Wealden." This was carelessly expressed: the great unconformity is undoubtedly at the base of the Lower Greensand, but we certainly did think that the Wealden overlapped the Upper Purbeck. Whether it really does so depends on the correct separation of the Wealden from the Purbeck. The bare idea of a break at the base of the Wealden fluttered the dovecotes of Jermyn Street to such an extent that the question seems to have assumed proportions of paramount importance in the minds of Messrs. Woodward and Reid. Others, however, may deem it of equal importance that the divisions of the Purbeck Series should be established on logical grounds, that the thickness of each group should be carefully estimated, and that the outcrop of the Wealden Beds should be carefully discriminated from that of the Upper Purbecks.

Finally, Mr. Reid's reference to *Endogenites erosa* adds nothing to the strength of his position. He admits that "it is too doubtful a form to be of much value for correlation," but immediately adds, "though its presence supports the view that the strata containing it truly belong to the Wealden period, and are not, as supposed by Messrs. Jukes-Browne and Andrews, of Purbeck age." He quite ignores the fact that we found a large piece of similar endogenous wood in the Upper Purbeck sand of the Dinton cutting. It is also a fact that pieces of *Endogenites erosa* have been found close to the spots where outliers of the Upper Purbeck are shown on the map, and when it is remembered that the fossil wood has never been found in the beds referred by Messrs. Woodward and Reid to the Wealden, it will be apparent that the facts are much more in accord with our view than with Mr. Reid's.

In conclusion, I may place on record that I have submitted one of the surface fragments to Mr. A. C. Seward, and he kindly informs me that he believes it to be the true *Endogenites erosa*, now known as *Tempskya Schimperi*, and in reality the stem of a tree-fern. Unfortunately, I could not send him a piece of the wood found in the sand at Dinton, and cannot therefore affirm that it was also *Tempskya*, but it was so similar that I took it to be the same.

I append a revised estimate of the total thickness of the Purbeck Beds in the Vale of Wardour, if the Upper group is to be restricted within the limits indicated by Mr. Woodward.

	ft.	in.	
Mean thickness from top of No. 30 to base of limestone with *Unio* (part of 21)	12	0	Upper Purbeck, 22 feet.
Yellow sands with *Endogenites*	6	0	
Grey clays and marl	4	0	
Thickness from top of No. 19 to top of the *Archæoniscus* bed (No. 13)	7	0	Middle Purbeck, 22¼ feet.
From top of No. 19 to top of cinder bed (south of Teffont)	4	3	
From top of cinder bed to base of the 'scale' below the flagstone at Teffont	11	0	
From base of 'scale' to marl-band below the 5th Lias	15	9	Lower Purbeck, 64½ feet.
Section in Ridge quarry from marl below 'Lias' to bottom of quarry	19	10	
Allowance for gap between quarries	7	0	
Section at Wockley from surface to base of Purbeck Beds	22	0	
Total	108	10	

IV.—The Disappearance of Limestones in High Teesdale.[1]

By C. T. Clough, M.A., F.G.S., of H.M. Geol. Survey.

In High Teesdale, on certain hillsides, the structure of which is in most respects clear, the observer is struck by the disappearance of some, generally constant, limestone which ought naturally to occur. The limestone most usually missing is the Great Limestone, which, with the exception of the Melmerby Scar Limestone, is the thickest of all in the dale. Though the ground is almost free from peat and drift, and plainly shows the banks formed by the Four Fathom Limestone and Firestone,[2] there is yet perhaps neither bank nor 'shake-hole' (swallow-hole) to represent the Great Limestone. In the cases referred to the difficulty cannot be accounted for by supposing that the limestone along its outcrop is thrown out by a fault, for the outcrops of the beds above and below can be followed round the hill without interruption.

Where the limestone disappears many masses of sandstone are usually found, most of which seem somewhat disturbed; and, in the small streams, thin irregular bands of soft, rather siliceous, clay and iron ochre occur. The clay and ochre represent the limestone, which, in the language of the dalesmen, has been 'eaten away' along the outcrop and replaced by 'famp.'

[1] The substance of this communication was written 25 years ago. Since then Mr. F. Rutley has written "On the Dwindling and Disappearance of Limestones" (Q.J.G.S., 1893, vol. xlix, p. 372), but he makes no mention of their special liability to dwindle in the neighbourhood of faults and veins, and gives no instances of their disappearance on a large scale. Mr. J. R. Dakyns has written a short paper "On 'Flots'" (Report Brit. Assoc., 1881, p. 634), and the material in many 'flots' seems of much the same nature as 'famp.' The writer has recently seen an instance of famping, differing somewhat from the examples in Teesdale, in one of the limestones (the Skateraw Middle Limestone), which has been quarried at Cateraig, near Dunbar, and this has recalled the subject to him.

[2] The Four Fathom Limestone is a little below the Great, and the Firestone is a sandstone a little above the Great Limestone.

The best locality for observing 'famp' and the accompanying phenomena is at the Highfield 'hushes,'[1] above Grasshill. It is there seen in clear section that the Great Limestone, the average thickness of which in the neighbourhood is 55 feet, is replaced by 10 or 12 feet of soft siliceous, irregularly banded, ochreous clay. Several veins cross the hushes, and near these veins low rambling levels have been driven in search of lead ore. Such work gives rather uncertain returns, for there are no straight or constant strings of ore to follow, but every here and there nodular masses of ore, occasionally a foot or more in breadth, are met with, which seem on the whole to repay the miners. These masses often occur together in groups, the centre of the larger examples being composed of galena, and the outside usually of carbonate of lead, or of a mixture of carbonate, phosphate, and arseniate. In the smaller, those with a breadth of an inch or less, the mass is often composed throughout of the three last-mentioned ores without any galena. The outlines of most of the lumps are rounded, and they show no sharply defined crystals of galena like those common in the ordinary veins. The miners think that the famp-ore has been water-worn, and they are probably right in one sense, though the carbonate and phosphate of lead, etc., on the outsides of the lumps, are often in well-formed crystals which cannot have undergone rolling.

A few other minerals, associated with the lead ores in the adjacent veins, are also found in the famp. Besides these, there are hard round lumps, each consisting of a limestone centre and an outer coat, which shows a gradual passage between limestone and famp. No sandstone boulders have ever been noticed in famp.

It is usually stated that limestones are not so much famped 'under the hill' as at the outcrops, and the sections at the head of Highfield hushes seem to confirm this opinion. In the gutter made in 1876 to hush part of the famp, a series of small faults and local contortions were seen, which bring down the 'Coal Sills,' the sandstones next above the Great Limestone, to lower levels towards the south, the direction in which the outcrop of limestone should occur. We know that these disturbances do not affect the beds below the famp, for they were not met with in the Cowby level, which is driven nearly under this gutter. They seem due to the dwindling away of the limestone as it comes near the surface. Famp probably replaces the Great Limestone in Yad Moss level, South Lang Tae sike, Blackway Hole hushes, the West Beck and Old Langdon hushes, and Pikelaw hushes. It probably also occurs for most of the way between Blackway Hole and South Lang Tae sike, a distance measured along the outcrop of about a mile, from the Yad Moss level to some distance on the north side of Crook Burn, and for half a mile or more on the north side of Henrake hush.

The areas wherein limestone has been replaced by famp are sometimes sharply defined. In Pikelaw hushes, vertical walls of

[1] A hush is an artificial wash-out, made for the purpose of baring and cutting the strata and the veins which cross them. In the process of hushing a reservoir is made high on the hill, and the water is let out in a flood along the desired direction.

limestone, 20 or 30 feet high, stand (1876) close against sandstone and shale, but when the margins of the limestone are examined by hushing, etc., they show no vein, and they do not continue in nearly straight lines as most veins do. Parts of the limestone stand up like ruined towers on the floor of Blackway Hole hush, and it is said they remain much as they were when originally found sticking up in a mass of famp.

The famp in the Yad Moss level is mixed with irregular streaks of a black earthy mineral, part of which is probably a black ore of manganese. In the West Beck and Old Langdon hushes the famp consists of nearly pure iron ochre, and it would no doubt have been used for smelting if it had been in a more accessible locality. In Weardale a famp of similar character has long been largely worked for this purpose. The light yellow varieties of famp are sometimes used instead of whitewash, for painting over walls, etc.

The limestones in Teesdale, which, next after the Great Limestone, are most conspicuously famped, belong to the Melmerby Scar group of limestones, in the neighbourhood of Silver Band Mine, Cronkley Fell. These limestones and the Great are generally rather pure limestones (the Great usually contains about 95 per cent. of carbonate of lime), so that the famp cannot be solely the residue of their decomposition. The greater part of it must have been introduced from without. It is most abundant where veins of ore are most numerous, and it is probable that most of the famp material was introduced by the same agent which filled so many of the neighbouring veins with ironstone and other minerals.

Where an ironstone vein passes through limestone, the width of the vein is nearly always greater than in sandstone or shale, for the limestone 'cheeks' are converted into ironstone for a certain breadth at the sides of the vein. The ironstone has not only grown in the open fissure of the vein or fault, but has also replaced part of the limestone. This is shown by the casts of corals, crinoids, etc., which are found in the ironstone. In a similar way, also, where a quartz vein passes through limestone, the limestone on the sides is partly replaced by finely crystallized quartz.

We suppose that the fissures made in the course of earth movements formed channels for the circulation of water holding various minerals in solution, and that this water not only deposited minerals in the fissures, but also gradually dissolved part of the limestone it passed through, and deposited other minerals in its place. The replacement effected along the sides of the veins varies greatly in extent, and it is probable that a replacement by carbonate of iron was the first stage in the manufacture of famp.

But why is the limestone more often dissolved away along the outcrop than elsewhere? It appears as if the action, which was first started by water circulating along the veins, had been continued and modified in recent times, since the present surface of the ground was developed, and that this later action is perhaps still in progress.

It is obvious that where a limestone was already partly dissolved away near the outcrop, the ground above would be affected by local

faults and slips, and would be specially liable to penetration by surface-water, which, already charged with carbonic acid, would therefore be well suited for dissolving more of the limestone. The same surface-water which dissolved the additional portion of limestone, may also have altered the character of the substances which were first formed near, or in place of, limestone, partly mechanically, by rearranging them, and partly chemically, by converting the carbonate of iron into the hydrated peroxide,[1] and galena into other salts of lead. It would, of course, take longer to completely change the larger masses of galena than the smaller, and hence in the larger a centre of unchanged galena still often remains.

It may be noted, in conclusion, that these instances of solution of limestone on a large scale show one method by which the higher beds in a series may be faulted and folded while the lower beds remain undisturbed.

V.—The Palæontological and Geological Collections of the Bohemian Museum in Prague.

By Dr. Ant. Fritsch.

(PLATE XIV.)

AFTER transferring the collections to the new building in the year 1892, more than ten years work was necessary to finish the arrangement of 251 cases, which occupy seven large rooms. Now nearly all this labour is completed, and those who are interested in palæontology will be glad to learn some details as to the general arrangement of the Museum.

All fossils are fixed on tablets, or placed in glass-topped boxes. The labels are printed on greenish paper, and contain references to the work and plates where the type-specimens are described and figured. Beneath very small fossils is fixed a magnified figure taken from the book[2] where the species has been published. The under side of the tablets is used for white labels with further (written) details, catalogue numbers, etc. The inclination of the cases is 45° or 60°. Six rooms are devoted to the geology and palæontology of Bohemia and one large room to the general stratigraphical collection.

The first room, called "Barrandeum" (26 metres long), contains the famous collection of Barrande, in which are incorporated the old Museum collection, the collections of Bishop Zeidler, of Corda and Hawle, and of Professor Novák. In six wall-cases are exhibited representative specimens of the chief Azoic, or Eozoic, Primary and pre-Cambrian rocks of Bohemia, on which the younger formations are deposited. Sixty glazed cases contain the Cambrian, Silurian, and Devonian fossils, arranged in stratigraphical order. In the drawers beneath, the specimens are arranged in zoological order in

[1] See Professor J. W. Judd, "Geology of Rutland" (Mem. Geol. Surv.), p. 135.
[2] See my article in *Natural Science*, vol. viii (1896), No. 49.

THE ROYAL BOHEMIAN MUSEUM, PRAGUE.

such a way that every type-specimen of Barrande's can be quickly and readily referred to. Each case exhibits in its upper part about 100 objects, and beneath each are 18 drawers (in three rows) of specimens for purposes of scientific study. A special case is devoted to the memory of J. Barrande, showing a copy of his monumental work (28 vols. 4to, containing 1,454 plates, giving illustrations of more than 4,800 species from the Bohemian Palæozoic Basin); then a photograph of the memorial tablet fixed on the Silurian rocks near Kuchelbad, and a photograph of the house in which he resided in Prague during 40 years, together with the tools he used in developing his fossils, and his portrait when he first arrived in Bohemia.

The second room, called "Sternbergeum," about 100 square metres, contains the type-specimens of the work of Count Caspar Sternberg, "Flora der Vorwelt." In a central pavilion are grouped about 40 large and striking examples of Carboniferous plants, forming a pyramid, on the summit of which is placed a bust of Sternberg in Carrara marble. In two of the wall-cases are placed the Arachnida and Scorpions of the Coal-measures, 25 species represented by about 60 specimens.

The third room is a laboratory of phytopalæontology.

The fourth room, 100 square metres, contains the stratigraphical collection of the Bohemian Coal-measures, with type-specimens of Feistmantel's works. Then follows the Permian formation, with the type-specimens of the work "Fauna der Gaskohle" by the writer. The last of the 28 cases shows a rare collection obtained from the Jurassic beds in northern Bohemia, being the type-specimens of Dr. Bruder's work.

The fifth room, of equal proportions, contains the Chalk formation of Bohemia, displayed in 28 cases. Three cases contain a splendid exhibition of the Cenomanian flora described by MM. Velenovsky and E. Bayer. The marine fossils from different stages (Cenomanian-Senonian) are here shown as documents in evidence of the monographs published by myself in the "Archiv für Landesdurchforschung Böhmens," exhibited in 25 cases.

The sixth room is devoted to the Tertiary (lacustrine) formation of Bohemia, and shows in 28 cases a rich flora and fauna (fishes, insects, mollusca, and a great part of the skeleton of *Dinotherium* found near Abtsdorf, and many other mammalian remains).

The last room of the series, devoted to Bohemian geology and palæontology, contains in 12 cases the diluvial and alluvial fauna, the vertebrates described by Kafka, and the mollusca by Babor. There are also exhibited specimens to illustrate the lithological character of each period. In a central pavilion are displayed the remains of *Elephas*, *Rhinoceros*, *Cervus*, *Bos*, etc. Near the window is exhibited a complete skeleton of the Rhinoceros found near Pardubic.

In all the rooms named above are also displayed geological maps showing the geographical distribution of the formations in Bohemia, and diagrammatic coloured sections of the principal localities,

accompanied by rock-specimens from each zone or layer of every formation occurring in Bohemia.

Finally, we come to a large room, 26 metres long, in which is arranged in 60 cases a general stratigraphical collection. Here are exhibited for comparison, besides Bohemian specimens, those of England, France, Germany, Russia, America, etc., giving an adequate idea of the character of each formation in other countries. Beneath the windows are placed four table-cases with a general dynamical collection, with large explanatory labels. Against the wall, upon two large stands, are exhibited casts of remains of great vertebrates, and upon the opposite wall hang geological and palæontological pictures and diagrams.

The scientific work carried on by the staff of the Geological Department is as follows:—Gasteropoda of Bohemian Palæozoic Basin (continuation of Barrande's work), by Dr. J. Perner; newer Cretaceous Plants, by Dr. Edvin Bayer; Arachnids from the Coal-measures, by Dr. Ant. Fritsch; Fishes and Reptiles of the Bohemian Chalk formation, by Dr. Ant. Fritsch and Dr. Bayer; Graptolites, their geological distribution in Bohemia, by Dr. J. Perner; Tertiary plants and insects from Bohemia, by the Junior Assistants.

A new guide to the collections is now being prepared. The original specimens are always accessible to all scientific investigators, but cannot be sent away to other Museums.

VI.—On a Fault at the Foot of Tainton Downs.

By Edwin A. Walford, F.G.S.

To the north of Tainton, near Burford, Oxon, the 500 O.D. contour-line passes through the old quarry grounds where the well-known Great Oolite freestone may be seen dipping at a high angle to the north-east. The bank falls 100 feet to the brook, 400 yards distant, where culvert and pipe trenches for new field waterworks have exposed what may be a continuation of a fault marked on the one-inch geological map of the Ordnance Survey as following the course of Coombe Brook, a mile to the north.

The Great Oolite runs half-way down the bank, and is underlain by a few inches of the pale grey marl of the Fuller's Earth. The Fuller's Earth is unfossiliferous, and recognizable only by its lithological type and horizon. Between the Fuller's Earth and the heavy blue clays of the Upper Lias are two or three feet of sandy limestone, iron-stained, representing the Inferior Oolite. At the bottom of the trench thick blocks of brown and green ferruginous limestone are of the Middle Lias (zone *Ammonites spinatus*), with the following fossils, *Avicula inæquivalvis*, Pentacrinite segments, and rolled Belemnites, in a nodule bed, a stratum in North Oxfordshire well known as the base of the 'Marlstone' of the Middle Lias. The stone is of the typical Oxfordshire type, close-grained, oolitic, and of a dark green colour. It gives appearance of a former well-developed extension over the area. It must not be forgotten, however, that the Burford Signett boring for coal in 1874 proved but 3 ft. 6 in. of Middle Lias stone.

In the steep roll of the bank near the brook, in 40 feet, are represented strata of the

Great Oolite,
Fuller's Earth,
Inferior Oolite,
Upper Lias,
Middle Lias,

the wasted remnant of a thousand feet of rock and clay of the higher north-west Cotteswolds.

The dip into the hill on the downs of the Tainton Great Oolite freestone suggests the probability of a high fault line along the downs parallel with the low line of fault described. It may be safely surmised that the curved line of fault mapped by the Survey joins the one at the Waterworks nearer Tainton, and it is probable that the upper line of fault meets the long fault seen to be trending from east to west above Burford and near Waterloo Farm.

ADDENDUM.—NOTE ON THE MICROSCOPIC TYPE OF THE MARLSTONE OF TAINTON.

The stone is of the usual dull green colour, weathering to a reddish brown. It has the granulated appearance of the bottom stone of North Oxfordshire, though it is really not of so oolitic a type.

In section it is shown as a mass of ferro-crinoid segments, held together by a matrix of clear calcite of which but little is seen. The segments or plates are pentagonal, ovoid, orbicular, or of irregular shape, and are pierced with rounded openings.

Scattered throughout the mass are olive-coloured patches or granules of ferrous carbonate, with oolitic grains of the same colour, of ovoid or irregular shape, and of small size. When solidified they pass from a pale olive brown to a deeper rich brown colour. The interspaces and passages of foraminifera and other organisms are filled with the same mineral. There is no trace of concentric banding or lamination in the oolitic grains, which appear to be decomposed rather than fully formed.

It is remarkable that in strata of such great waste the organic structure of the ferro-crinoid, which I have elsewhere shown to be the main constituent of the Middle Lias ironstone, should remain, and that the oolitic stage should be so feebly developed.

NOTICES OF MEMOIRS, ETC.

AN ENQUIRY INTO THE VARIATION OF ANGLES OBSERVED IN CRYSTALS, ESPECIALLY OF POTASSIUM-ALUM AND AMMONIUM-ALUM.[1] By Professor H. A. MIERS, M.A., D.Sc., F.R.S.

CORRESPONDING angles measured on different crystals of the same substance usually differ slightly. On cubic crystals the theoretical angles are known. Pfaff professed to have established

[1] Abstract of a paper read before the Royal Society, March 26, 1903.

that only those cubic crystals which display birefringence exhibit divergence from the theoretical angles, but Brauns showed that in lead nitrate, ammonia-alum, and spinel, for both isotropic and birefringent crystals alike, the octahedron angle may differ by as much as 20′ from that of the regular octahedron.

The author has endeavoured to trace the changes of angle upon one and the same crystal during its growth by measuring it at intervals without moving it from the solution in which it is growing. This is accomplished by means of a new telescope-goniometer in which the crystal is observed through one side of a rectangular glass trough, and the changes in the inclination of each face are followed by watching the displacements of the image of a collimator slit viewed by reflection in it. The crystal is held by a platinum clip which it envelops as it grows. Small movements of the image are followed by means of a special micrometer-eyepiece which accurately measures the magnitude and direction of the displacement.

Examined in this way an octahedron of alum (ammonium or potassium) is found to yield, not one, but three images from each face; and closer inspection shows that the crystal is not really an octahedron, but has the form of a very flat triakis-octahedron. It often happens that of the three faces which nearly coincide, one is large and the remaining two very small, so that of the three images one is bright and the others are very faint and can only be discerned with difficulty; in such a case the crystal as measured in the ordinary way would appear to be an octahedron whose angle differs from the theoretical value by a few minutes.

When a growing crystal of alum is watched for several hours or days, it is found that the three images yielded by an apparent octahedron face continually change their position; one set fades away and is replaced by another set which are generally more widely separated than those which they succeed. The images move in three directions inclined at 120° to each other, and indicate that these faces always belong to a triakis-octahedron. The point in which the lines of movement intersect within the field of view of the telescope would, therefore, be the position of the image reflected from the true octahedron face. Measured in this way the octahedron angle of alum is found to be the theoretical angle 70° 31$\frac{3}{4}$′.

The images do not move continuously, but *per saltum*, indicating that the reflecting planes are vicinal faces which probably possess rational indices, and must therefore be inclined at certain definite angles to the octahedron face; but the indices are very high numbers.

Observations upon sodium chlorate, zinc sulphate, magnesium sulphate, and other substances show that other crystals exhibit the same behaviour. The faces of a crystal are in general not faces with simple indices, but vicinal planes slightly inclined to them, and they change their inclinations during the growth of the crystal; they also change their inclinations when the crystal is immersed to a greater or less depth in the solution.

Every point within a crystal has at some time been a point on the surface, and has been subject to the conditions of equilibrium

between crystal and solution which prevail there. It is believed by the author that a study of the vicinal planes and of the liquid in contact with them, may lead to some understanding of these conditions.

In order to ascertain the composition of the liquid, attempts were made to determine its refractive index by means of total reflection within the crystal. This appears, indeed, to be the only method which can give direct information concerning the ultimate layer in contact with the growing face, and it is somewhat remarkable that it has not been applied before. Considerable difficulty was experienced in making this measurement, but ultimately good readings were obtained which gave the value 1·34428 as the refractive index in sodium light, at 19° C., of the liquid in contact with a growing crystal of alum. The refractive indices of a series of solutions of known strength, ranging from dilute to supersaturated, having been previously measured, the above index was found to correspond to a liquid containing about 10·80 grammes of alum in 100 grammes of solution. A saturated solution at 19° C. was found to have the refractive index 1·34232, and to contain about 9·01 grammes of alum in 100 grammes of solution.

Sodium chlorate was examined in the same way: it was found that the liquid in contact with a growing crystal has at 19° C. the index 1·38734, and contains about 47·8 grammes of salt in 100 grammes of solution; a saturated solution of sodium chlorate at 19° C. has the index 1·38649, and contains about 47·2 grammes of salt in 100 grammes of solution.

The liquid in contact with a growing crystal of sodium nitrate has at 19° C. the index 1·38991, and contains about 48·45 grammes of salt in 100 grammes of solution; a saturated solution at 19° C. has the index 1·38905, and contains about 48·1 grammes of salt in 100 grammes of solution.

In each case the liquid in contact with the growing crystal is slightly supersaturated. It was not found to exhibit double refraction even in the case of sodium nitrate. No experiments seem to have previously been made upon the nature of this liquid.

G. Wulff has suggested that vicinal faces are due to concentration streams in the solution. In order to test this view, crystals of alum were measured after growing for several hours in solution kept continually agitated in order to eliminate the action of the concentration streams. Almost no effect was produced upon the angles of the vicinal faces.

In sodium chlorate and sodium nitrate the solute is about 45 times more dense in the crystal than in the adjacent liquid. Now planes with high indices in a space-lattice contain fewer points in unit area than planes with simple indices. The author suggests that vicinal faces grow upon a crystal in preference to simple forms because the crystallising material descends upon the growing face in a shower which is not very dense.

REVIEWS.

I.—North German Neocomian Ammonites. Die Ammonitiden des Norddeutschen Neocom (Valanginien, Hauterivien, Barrêmien, und Aptien). By Professor Dr. A. v. Koenen. pp. 451, 55 plates, and 2 text illustrations. Abhandlungen der Königlich Preussischen Geologischen Landesanstalt und Bergakademie, Neue Folge, Heft 24, 1902.

PROF. DR. A. v. KOENEN is so well acquainted with the Neocomian deposits of Northern Germany that we heartily welcome the present work, which forms the first part of a monograph of the fauna of those beds. This portion is devoted entirely to a consideration of the Ammonoids; the Nautiloids, Dibranchs, Gastropoda, and Pelecypoda being reserved for the second part. The bibliography of the subject, most carefully prepared by the author, occupies some eight and a half pages, and gives one some idea of the amount of literature relating to these deposits. About 15 pages are devoted to the stratigraphy of the Neocomian beds of North Germany, whilst the description of their Ammonoid fauna occupies some 360 pages.

In the North German Neocomian beds, that is, in the beds belonging to the Valanginien, Hauterivien, Barrêmien, and Aptien, that occur between the Berriasien (= Wealden) and the Albien (=Gault), the author recognises the following fifteen distinct zones:—

Albien = Gault.			
Aptien.	Upper.	Zone of	*Hoplites furcatus*, Sow.
	Lower.	,,	*Hoplites Deshayesi*, Leym.
		,,	*Acanthoceras Albrechti Austriæ*, Hohn., and *Hoplites Weissi*, Neum. & Uhlig.
Barrêmien.	Upper.	,,	*Ancyloceras trispinosum*, v. Koen., and *Desmoceras Hoyeri*, v. Koen.
		,,	*Ancyloceras innexum*, v. Koen., and *Crioceras pingue*, v. Koen.
		,,	*Crioceras Andreæ*, v. Koen., *C. Denckmanni*, G. Müll., and *Ancyloceras costellatum*, v. Koen.
	Lower.	,,	*Crioceras elegans*, v. Koen.
		,,	*Crioceras fissicostatum*, Roem., and *Ancyloceras crassum*, v. Koen.
Hauterivien.	Upper.	,,	*Olcostephanus Phillipsi*, Roem., and *Crioceras Strombecki*, v. Koen.
	Lower.	,,	*Crioceras capricornis*, Roem.
		,,	*Hoplites noricus*, Roem., and *H. radiatus*, Brug.
Valanginien.	Upper.	,,	*Crioceras curvicosta*, v. Koen., and *Ole. terscissus*, v. Koen.
		,,	*Ole. psilostomus*, Neum. & Uhlig, and *Saynoceras verrucosum*, D'Orb.
	Lower.	,,	*Ole. Keyserlingi*, Neum. & Uhlig, and *Ole. Brancoi*, Neum. & Uhlig.
		,,	*Oxynoticeras Gevrili*, D'Orb., and *O. heteropleurum*, Neum. & Uhlig.
Berriasien = Wealden.			

More than two hundred species are described, and nearly all of them figured in an admirable manner in the fifty-five plates accompanying the work. The species are grouped in about twenty genera,

of which the more numerously represented are *Hoplites*, *Crioceras*, *Aneyloceras*, and Neumayr's *Olcostephanus* (or *Holcostephanus*), with its subdivisions *Craspedites*, *Polyptychites*, *Astieria*, and *Simbirskites*, proposed by Professor Pavlov, the author following the late Professor Hyatt in regarding Pavlov's divisions as of generic importance. A very large proportion of the species are new; but there are no new genera.

For this valuable contribution to our knowledge of the fauna of these beds in North Germany, Professor v. Koenen deserves the hearty thanks of all, and especially of those who are more particularly interested either in the Lower Cretaceous rocks as a whole or in their Cephalopod fauna, and we are sure that many will look forward with eagerness to the appearance of the second part of this excellent monograph.

II.—Memoirs of the Geological Survey of England and Wales.

IT is again our pleasant task to call attention to the work of the Geological Survey, and to offer our congratulations to the Director, Mr. J. J. H. Teall, F.R.S., and to the Board of Agriculture, under whose auspices the publications of the Survey Memoirs now appear, upon the excellent series recently presented to the public.

1.—The Geology of the South Wales Coalfield. Part III: The country around Cardiff, being an account of the region comprised in Sheet 263 of the Map. By Aubrey Strahan, M.A., F.G.S., and T. C. Cantrill, B.Sc. 8vo; pp. vi and 148, with 13 text figures. (London: E. Stanford (or of Messrs. Dulau & Co., 37, Soho Square, W.), 1902. In paper wrapper, price 2*s.* 3*d.*)

The district of the South Wales Coalfield is one with which Mr. Strahan is specially acquainted, and this third memoir upon it forms the explanation to Sheet-map No. 263. The area was originally surveyed, about the year 1840, by Sir H. T. De la Beche, with the assistance of Mr. W. T. Aveline,[1] but additions, chiefly in the Secondary rocks, were made in 1872 by H. W. Bristow and H. B. Woodward. The re-survey on the six-inch scale was carried out during the years 1892–6, under the superintendence of Mr. Strahan, the author of this memoir, who himself surveyed the greater part of the sheet, while Mr. Cantrill was engaged upon the western part, and has supplied the descriptions of the area surveyed by himself.

The oldest strata, consisting of Ludlow and Wenlock rocks, come to the surface near Cardiff in the axis of a great anticline of pre-Triassic age. Their existence was first detected by the Rev. Norman Glass in 1861, but it was not until 1879 that their extent and age were placed beyond doubt by Professor W. J. Sollas. Much information concerning them was obtained at a later date also by Mr. John Storrie.

The Old Red Sandstone presents the same general features as in

[1] An obituary notice of this veteran geologist will be found on pp. 285–286 of the present Magazine.

Monmouthshire, and the precise position of the boundary between the Upper and Lower Old Red Sandstone still remains doubtful.

The Carboniferous Limestone is concealed for the most part by later rocks, but is evidently far thicker on the southern than on the northern side of the coalfield, as is the case with all the subdivisions of the Carboniferous system.

Among the most interesting features of the geology is the partial uncovering of a pre-Triassic landscape by the denudation of the Trias and Lias from parts of the platform of Palæozoic rocks upon which they were deposited. Not a few old headlands and islands have thus been brought to light, and some are even playing the same part in the present seascape which they played in Triassic times. All these facts received full recognition from De la Beche.

In the examination of the Rhætic and Liassic beds the surveyors have availed themselves of the detailed work of H. W. Bristow, R. Etheridge, and H. B. Woodward, and of the additions made to it by Mr. John Storrie and Mr. F. T. Howard.

Superficial geology is well illustrated in the neighbourhood described in this memoir. The raised beach so well known round the shores of the Bristol Channel exists near Weston-super-Mare, and the suggestive observation of Mr. E. C. H. Day as to the age of the bones contained in it have received confirmation from recent observations in Gower, where the beach and its associated 'head' are seen to be of earlier date than the local glacial drift. Recent work on the glacial deposits confirms Professor Edgeworth David's conclusions made in 1883.

Post-glacial deposits were admirably displayed in the excavations at the Barry Docks, where conclusive evidence was obtained of a subsidence of the land of upwards of 50 feet during and since Neolithic times. In this investigation also Mr. Storrie gave valuable assistance.

The Map is issued in two editions. On the edition for Solid Geology the Glacial Drift is omitted, while on the Drift edition the areas occupied by Drift are coloured, as well as those portions of solid geology which are not concealed by the Drift. Manuscript six-inch maps, geologically coloured, are deposited in the Office, where they can be consulted. Copies of these maps can be obtained at cost price. It is much to be regretted that a geologically coloured map is not, as a rule, issued with every Survey Memoir.

The figures given in the text leave much to be desired (see p. 58). Surely clearer figures and better printing ought to be insisted upon from the King's Printers at the present day.

The memoir is accompanied by an excellent index.

2.—Index to Report on the Geology of Cornwall, Devon, and Somerset, by Sir Henry T. De la Beche, C.B., F.R.S. Index compiled by Clement Reid, F.R.S. pp. 34. Printed for H.M. Stationery Office. (London: E. Stanford (or of Messrs. Dulau & Co., 37, Soho Square, W.), 1903. Price 1s.)

The Geological Survey have done good service to science in printing this Index to De la Beche's "Report" on the Geology of

Cornwall, Devon, and West Somerset, most carefully compiled by Mr. Clement Reid, F.R.S. Notwithstanding the fact that De la Beche's "Report" was published in 1839, it was destitute of an index. No less than 1,500 copies were issued, and the memoir is now out of print. It has, however, become one of the classics of geology, and being a permanent work of reference an index has been a great desideratum, which is now supplied by Mr. Clement Reid, and should be bound up with every existing copy of this valuable memoir.

Copies of this Index may be obtained from any agent for the sale of Ordnance Survey maps, or through any bookseller, from the Ordnance Survey Office, Southampton.

3.—The Geology of the Isle of Man. By G. W. Lamplugh, F.G.S. With Petrological Notes, by Professor W. W. Watts, M.A., F.G.S. 8vo; pp. xiv and 620, with a geologically coloured map. Printed for H.M. Stationery Office. (London: E. Stanford (or of Messrs. Dulau & Co., 37, Soho Square, W.), 1903. Bound in cloth, price 12*s*.)

It is not often that one geological surveyor has the pleasure and satisfaction of seeing his name recorded as having completed a memoir entirely by himself. Prof. J. W. Judd had the honour, when on the Survey many years ago, to survey a whole English county, that of Rutland; but Mr. Lamplugh has surveyed a whole island; nay, more, for was not Man a kingdom in itself up to 1765, when the heiress of the Duke of Athol ceded her rights as Lord of Man to the Crown; but it still has its own Parliament (the House of Keys). Rising in the middle of the Irish Sea (with a length of 34 miles and a breadth of from 10 to 12 miles), it has an area, including 'the Calf' off its south-western extremity, of 227 square miles (145,325 acres), of which 170 square miles, or three-fourths of the whole island, are occupied by slate and greywacke rocks, probably of Upper Cambrian age, composing the hilly massif. Strata of Lower Carboniferous age occur in a small basin of 7 or 8 square miles at a low elevation in the south of the island; and a narrow strip of red sandstone, probably belonging to the same period, borders the coast for 2 miles about midway upon the western side. The northern extremity consists of a low-lying tract of about 45 square miles, which is an addition made to the Island in Glacial times by the deposition of great masses of glacial drift upon the pre-Glacial sea-floor. Deep borings through this drift have recently revealed a rock floor of Triassic, Permian, and Lower Carboniferous strata at a considerable depth below sea-level.

The following table of strata shows the divisions which have been adopted for the one-inch map of the Geological Survey, published in 1898. The more southerly portion of the northern drift plain may possibly be underlain by rocks intermediate in age between the Manx Slate Series (Upper Cambrian ?), which bounds it on the south, and the Lower Carboniferous strata, which have been proved in the borings at its northern margin. No divisions have been

introduced which have not been actually proved to exist within the area.

TABLE OF STRATA FOR THE ISLE OF MAN.

RECENT	Blown sand.	
	Peat.	Fresh-water.
	Alluvium.	Fresh-water.
	Raised Beach.	Marine.
GLACIAL	Late Glacial Flood-Gravels.	
	Sand and Gravel occurring as platforms.	
	Sand and Gravel occurring as mounds.	
	Boulder-clay or Loam, and Rubble Drift.	
	Great Unconformability.	
TRIASSIC	Red Marls (saliferous).	Proved in deep borings beneath the drift-plain at the northern end of the island.
	St. Bees Sandstone.	
PERMIAN	Lower Marls and Brockram.	
	Great Unconformability.	
CARBONIFEROUS ...	Carboniferous Limestone Series.	
	Basement Sandstone and Conglomerate.	
	Great Unconformability.	
UPPER CAMBRIAN?	Manx Slate Series (locally divided into)	Barrule Slates.
		'*Crush Conglomerate.*'
		Agneash and other Grits.
		Lonan and Niarbyl Flags.

CONTEMPORANEOUS.

IGNEOUS ROCKS ...	Carboniferous ...	Tuff Agglomerate, etc.
		Basalt.
	Manx Slate Series.	Tuff (*small patches near Dalby only*).
		Intrusive.
	Olivine Dolerite (Tertiary?) dykes.	
	Diabase, etc. ('Greenstone') dykes.	
	Diabase, Epidiorite, Chloriteschist, etc. ('Altered Greenstone'), dykes.	
	Diorite and Camptonite dykes.	
	Mica-trap dykes.	
	Microgranite dykes.	
	Granite.	

The geological maps of the island, of which Mr. Lamplugh's memoir contains a very full and admirable description, are issued in two editions, one with and the other without the Drift.

Besides the chapters of topographical details regarding the rocks of the island which are arranged to serve as a geological guidebook to those in search of local information, the work contains general chapters in which a broader method of treatment is adopted and prominence is given to the phenomena of more than local interest. Thus, the descriptions of the physical features of the island, of the 'Crush Conglomerate' and other curious rock structures and types of folding produced by earth-movement in the Manx Slates, of the disturbance of a different character exhibited by the Carboniferous rocks, of the structure of the Irish Sea basin as revealed by deep borings in the north of the island, and of the condition of the island during the successive stages of the Glacial Period,—all contain matter of wide geological interest. The chapters on the petrography of the great variety of most interesting igneous rocks and of those of sedimentary origin have been prepared by Professor W. W. Watts.

Under the heading of Economic Geology there will be found a general account of the rich metalliferous veins for which the island is noted, and a careful description of the very numerous mine workings and trials that have been carried out in exploiting or testing these veins. The book is illustrated by very numerous plates, figures, and sections.

We congratulate the author upon this very excellent and well-prepared volume. But greater attention should be given by the printers to the reproduction of the illustrations in the text, which still leave much to be desired. The collotype plates are admirable, and mark a distinct advance in the publications of the Geological Survey.

III.—Memoirs of the Geological Survey of Scotland.

1.—The Geology of Lower Strathspey (Explanation of Sheet 85). By L. W. Hinxman, B.A., F.R.S.E., and J. Grant Wilson; with Petrological Chapter and Notes by J. S. Flett, M.A., M.B., C.M., D.Sc. 8vo; pp. vi and 92, with 3 plates and 3 text figures. (Printed for H.M. Stationery Office by James Hedderwick & Sons, Glasgow. J. Menzies & Co., Edinburgh (or of Messrs. Dulau & Co., 37, Soho Square, London, W.), 1902. Price 1*s.* 6*d.*)

THIS memoir describes the geology of Lower Strathspey, a district embracing 432 square miles in the counties of Elgin and Banff. Special attention is given to the development of the topographical features of the region. The metamorphic and igneous rocks are described, and a section is devoted to the petrography of the area by Dr. J. S. Flett. In connection with the Old Red Sandstone of Lower Strathspey, reports are given in the Appendix by Dr. R. H. Traquair, F.R.S., "On the Fishes of the Old Red Sandstone," and Mr. R. Kidston, F.R.S., on the fossil plants of the Old Red Sandstone of Scotland. The glacial deposits and economic products are described. The three process plates are excellent. A bibliography is given, and an index completes the work, but the geological map (Sheet 85) does not accompany the memoir.

2.—The Geology of Eastern Fife: being a description of Sheet 41 and part of Sheets 40, 48, and 49 of the Geological Map. By Sir Archibald Geikie, D.C.L., F.R.S.; with an Appendix of Fossils by B. N. Peach, F.R.S. 8vo; pp. xvi and 422, with 12 plates and a geologically coloured map and 71 figures in the text. (Printed for H.M. Stationery Office by James Hedderwick and Sons, Glasgow. J. Menzies & Co., Edinburgh (or of Messrs. Dulau & Co., 37, Soho Square, London, W.), 1902. Bound in cloth boards; price 8*s.*)

The memoir (like that by Mr. Lamplugh on the Isle of Man) is quite up to date, being issued bound in cloth, and accompanied by 12 plates and a geologically coloured map of Eastern Fife, besides numerous figures in the text. It is a district long since

explored by the Geological Survey for Scotland; and when its author, Sir Archibald Geikie (the late Director of the Survey), was quite a young man (engaged in planting the laurels which he now so gracefully wears) he wrote an admirable article on Old Volcanic Action at Burntisland (Fife) on the north shore of the Firth of Forth, and described a volcanic bomb he had observed in Carboniferous beds at King's Craig in 1862 (see GEOL. MAG., Vol. I, 1864, pp. 22–26).

The district described in this volume comprises that portion of the county of Fife which lies to the east of a north and south line drawn from the mouth of the River Leven on the Firth of Forth to Wormit Bay on the Firth of Tay. It completes the description of the geology of Fife, of which the first part, comprising the central and western divisions of the county, was published at the close of the year 1900. The account here given of the general geological structure of the ground and the distribution of the rocks has been based partly on the original field-maps just referred to and partly on copious detailed notes made by the author during repeated traverses of the ground. Having in earlier years had frequent opportunities of visiting the east of Fife, he had become familiar with its geology. But for the preparation of this memoir Sir A. Geikie spent a portion of the Spring of 1900 in examining many of the more important sections, and he also devoted the Summer and a portion of the Autumn of 1901 to the same purpose.

The unique feature in the geological history of this part of Central Scotland is presented by the series of some 80 volcanic vents distributed in a band, which crosses the peninsula from Largo to St. Andrew's Bay. Many years ago the author called attention to the nature and interest of these vents, and pointed out how important is the evidence which they furnish as to the internal structure of volcanoes. But up to the present time no complete and detailed account of the whole series of them has ever been published. He has accordingly made a renewed study of the subject, and has devoted four chapters to a full presentation of the facts and a discussion of their bearing on the history of volcanic action in this country.

The author acknowledges his great indebtedness to the late Mr. J. W. Kirkby for valuable assistance given him in preparing his account of the Carboniferous formation of the East of Fife. He generously supplied detailed tables of the coast-sections and careful manuscript notes (both palæontological and stratigraphical), which will be found embodied and indicated in this volume. No such careful and detailed work has been made of any part of the Carboniferous system of the British Islands as that carried out by Mr. Kirkby on the shores of Fife.

Mr. C. D. Geddes, mining engineer of Edinburgh, has furnished the author with records of all recent borings in East Fife in search of coal; but of late years little has been done to develop the mineral fields of the district, so that the maps remain much the same as when surveyed 40 years ago by Mr. H. H. Howell.

In the Appendix Mr. B. N. Peach, F.R.S., Mr. C. B. Crampton, and Mr. D. Tait furnish a general list of all the fossils obtained in Eastern Fife; assisted by Dr. R. H. Traquair, F.R.S., for the Fishes; Dr. Wheelton Hind for the Mollusca, etc.; Mr. R. Kidston, F.R.S., for the fossil Plants; Prof. T. Rupert Jones, F.R.S., and the late Mr. J. W. Kirkby for the Entomostraca, etc. These are arranged in stratigraphical groups, in botanical and zoological grade, and the localities are all given by means of numbers. Special lists of fossils are also added. The series of 12 plates are devoted mostly to volcanic and glacial phenomena, which the coast of East Fife admirably illustrates. We are glad to see the historic 'Rock and Spindle' still stands on the beach two miles east of St. Andrew's. This might, with advantage, have been reproduced on a larger scale, so as to bring out more effectively its remarkable features. Dr. J. S. Flett and Mr. H. J. Seymour contribute a chapter on the petrography of some of the rocks of Eastern Fife, and one recognises many effective sketches of geological phenomena from the notebook of Sir A. Geikie, reproduced as process cuts in the text. Certainly the King's printers in Scotland do their work better than those for England, and unless our London printers look carefully to their laurels the memoirs of the Survey are apt to be sent 'over the border' for production.

IV.—The Geological Survey of Ireland.

The Geology of the Country around Dublin (Explanation of Sheet 112). By G. W. Lamplugh, F.G.S., J. R. Kilroe, A. M'Henry, M.R.I.A., H. J. Seymour, B.A., F.G.S., and W. B. Wright, B.A. 8vo; pp. viii and 160, with 5 plates and 21 process illustrations in the text, and a coloured geological map (Sheet 112). (Printed for H.M. Stationery Office by Alex. Thom & Co., Limited, Dublin. Sold by Hodges, Figgis, & Co., Limited, 104, Grafton Street, Dublin (or of Dulau & Co., 37, Soho Square, London, W.), 1903. Price 3*s.*; price of Map 1*s.* 6*d.*)

[In part reprinted from the explanatory Memoir to accompany Sheets 102 and 112, by J. Beete Jukes, M.A., F.R.S., and G. V. Du Noyer, 1861; revised 1875.]

This memoir has been prepared to accompany and explain the new colour-printed drift-map of Dublin and its environs. The description of the 'solid' rocks is mainly reprinted from the original "Memoir to accompany Sheets 102 and 112," which has long been out of print, but this part has been expanded to include a summary of the researches carried out by private workers and by the Survey since that memoir was published, and a newly written portion dealing with the 'petrography' of these rocks has also been added.

The description of the glacial drifts and other superficial deposits is altogether new, and contains the information collected during the survey of these deposits in the year 1901. The material under the heading of 'Economic Geology' has been greatly enlarged from the previous memoir, and now includes a list of the minerals of the district and an account of researches into the character of its soils.

The previous geological literature of the neighbourhood is also for the first time discussed, under the heading of 'Bibliography,' and a list of this literature is given in an appendix. The memoir is illustrated by 5 plates from photographs, by R. Welch, of Belfast, and by 21 figures in the text.

The district included in this sheet lies wholly within the county of Dublin. The city of Dublin is in the centre of the sheet, and its suburbs extend along the shores of Dublin Bay to Dalkey on the south and Dollymount on the north, and also along the Liffey valley westward to Chapelizod. The watering-places of Howth and Killiney lie respectively north and south of Dublin Bay within the sheet, and the islet of Ireland's Eye occurs within its northern margin.

The southern part of the district is high mountainous ground, rising up to 1,763 feet above the sea at a point called Fairy Castle. There is another summit called Tibradden Mountain, which is 1,540 feet; and the better known Three Rock Mountain, everywhere visible from the neighbourhood of Dublin, is 1,479 feet high. A hill called Slieve na bawnoge at the extreme south-west corner is 1,265 feet. Of the lower hills, Killing Hill has a height of 512 feet, while the summit of that of Dalkey is 472 feet high, within a quarter of a mile of the sea. The mountains, like all granite mountains, have heavy-looking, gently sweeping summit outlines, their flanks descending gradually but rather steeply on the east towards the sea, and on the north to the plain traversed by the Dodder and the Liffey.

This plain spreads northwards from the foot of the hills, with gentle undulations of between 100 and 200 feet above the sea, rarely rising above the greater height, and often, especially near the sea or on the margin of brooks and rivers, falling below the lesser altitude. It forms a portion of the central plain of Ireland. In the north-western part of the map, however, north of Finglas, the land rises to a height exceeding 300 feet, and the rocky promontory of Howth has a summit of 560 feet in height. All the north-flowing drainage of the southern hill range is received by the River Dodder, which swerves eastward across the plain to the mouth of the Liffey, after issuing from the mountains through the deep hollow of Glenasmole, a little south of Tallaght. The eastern portion of the range is drained principally by two small streams which flow eastward into Killiney Bay. The Liffey, which has a level of less than 40 feet where it enters the district, brings the drainage from the plains of Kildare into the head of Dublin Bay, into which also runs the lesser river Tolka, with a course parallel to the Liffey, and only one to two miles further north.

The solid rocks of the district are shaly and massive Carboniferous Limestones, Lower Limestone shales and fine grits, Lower Silurian, Bala, and Llandeilo beds, altered Silurian grits and shales, Cambrian quartz rock, granite and basaltic andesites.

The memoir deals with (1) the solid geology; (2) the palæontology; (3) the petrography; (4) the relation between the external form of the ground and its internal structure, and hereunder to the consideration of Glacial and post-Glacial deposits

and their origin; (5) the detailed description of the solid rocks; (6) the detailed description of the drifts.

Then we come to the section Economic Geology—to the subject of mineral lodes, building materials, water supply, and agricultural geology.

Treated economically, the drifts are composed of blown-sand (forming sandy hillocks), recent intake (forming silt and made ground), alluvium, silty and loamy river-flats, peat and peaty-deposits. Raised beaches, pebbly sandy flats, river-gravel terraces (these are usually from 1 to 3 feet of loam on gravel). Late Glacial flood-gravel (forming stony loam on gravel tending to be water-logged). Sands and gravels of mounds and Eskers (forming dry stony loam on gravel, usually full of limestone). Sand and gravel intercalated in Boulder-clay (forming soil nearly like that of Boulder-clay). Boulder-clay containing much limestone (forming clayey loam with stones). Clayey drift mainly of non-calcareous material, including later hill-wash (forming a light, stony soil, varying with character of subjacent rock).

The five plates are admirably reproduced and well printed. There are also 21 sections and illustrations in the text, including a figure of *Oldhamia*, which is a very old friend indeed. The memoir will prove a very useful addition to the series of Geological Survey publications.

V.—Egyptian Geology.

Survey Department. Public Works Ministry [Egypt]. Geological Survey Report. Topography and Geology of the Eastern Desert of Egypt, central portion, by T. Barron and W. F. Hume. 8vo; pp. xii, 332, with maps, plates, and sections. (Cairo, 1902 [so dated, but issued May, 1903]. Price 400 milliemes (8*s.* 4*d.*).)

IN this Report, which has been expected for many months, the excellent arrangement of previous reports is followed of first giving a complete topographical survey of the region to be geologically surveyed. This brings together a great deal of useful material relating to Egyptology, meteorology, botany, and zoology, of considerable value when dealing with a new area, the features of the country being illustrated by a series of beautiful photogravures of striking scenery and points of geological interest.

The geology is the result of an examination by two parties of the staff during 1897–98, and the succession of beds dealt with includes Pleistocene, Pliocene, Miocene, Eocene, Cretaceous, all resting on volcanic and metamorphic rocks. The whole of the volcanic and metamorphic beds (with the exception of a few noted in the text) have been planed down by marine erosion, and the Nubian Sandstone has been laid down on the smoothed surfaces. This Nubian Sandstone is considered by the authors to be of Santonian age (Upper Cretaceous), there being no proof of beds older than that period in the district. The Cretaceous limestones overlying the Nubian Sandstone are mainly Middle Senonian (Campanian).

There is a marked unconformity between these strata and the overlying Eocene shales and limestones, which consist of two divisions, the Serrai limestones and the Esna shales, respectively of Londinian and Suessonian age. Andesites have been intruded into these beds, which are succeeded by Pliocene rocks, Oligocene being absent, and Miocene beds occurring only in the extreme north-east of the area. The Red Sea is considered to have come into existence in late Pliocene times, as the highest coral reefs (200 metres above sea-level) contain a possible mixture of Pliocene and Pleistocene corals. The youngest coral reefs are associated with gravels and conglomerates which must be of Pleistocene age.

Special chapters are devoted to Economics, which include gold and petroleum, and an interesting discussion is raised on the "Influences giving rise to the Eastern Desert structure." These influences may be summed up as follows: — (1) Its geological structure; (2) tectonic movements, folding and faulting, breaking up the plateau into isolated areas; (3) water; (4) insolation and changes of temperature; (5) mineral composition of the rocks and differences of their coefficients of expansion; (6) the dykes, as strong determinative factors in the hill sculpture; (7) wind, only effective where it has a supply of sand and plenty of space to act; (8) Nubian sandstone, and not granite, is the source of the sand; (9) sand action, in eating away the limestones along previously formed cracks.

The general get-up of the volume is highly satisfactory, the printing of the text, maps, and sections, which has all been done in Cairo, is excellent, the photogravures are by Albert, of Munich, and there is a singular absence of misprints. There is a voluminous index and a good bibliography, both quite indispensable to such a report. We would, however, ask the Director to insert the word "Egypt" after the word "Ministry" in the covers and title-pages of these reports, and to believe that the future difficulties which will arise from a book dated 1902, but not issued till 1903, are more real than at first sight appears. We are grateful for the list of publications which appears on the back of the cover, for in an unnumbered series of publications one is never certain how complete or incomplete one's set may be. C. D. S.

VI.—Notes on Cambrian Faunas. By G. F. Matthew, LL.D., with description of a new species of *Metoptoma*. (Trans. Roy. Soc. Canada, series II, vol. viii, sec. iv, p. 93.) 1903.

THIS article deals with several subjects relating to the Cambrian faunas of Canada. In the first note the differences in musculation, circulatory system, etc., of the Oboloid shells of the Cambrian in Canada are described. It is claimed that these shells belong to several subgenera. All but one are older than the type of the genus, *Obolus Apollonis*.

In the second note the enlargement during Cambrian time of the shells of several genera of Cambrian Inarticulate Brachiopoda is shown to have taken place.

In the third note proofs are shown that favour the view that the Upper Etcheminian fauna (Basal Cambrian) invaded Eastern Canada from the south-west.

In connection with the fourth note, in which the Brachiopodous shells of the Cambrian fauna of Mt. Stephen in British Columbia are dealt with, is the description of a new species of *Metoptoma*.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I. — April 29th, 1903. — J. J. H. Teall, Esq., M.A., F.R.S., Vice-President, in the Chair.

Prof. Bonney, in exhibiting three specimens found by Prof. Collie, F.R.S., on Desolation Valley Glacier, east of the watershed of the Rocky Mountains and a little south of the Canadian Pacific Railway, pointed out that one, a slab of white quartzite, was covered by horizontal worm-burrows, often about one-third of an inch in diameter, such as those named *Planolites* by Nicholson; another, of the same material, had blunt ridges, tapering to a point, an inch or so long, rudely parallel, in sets of about four. These he should have taken for the tracks of a (?) Crustacean, but they were single, not paired, and without any sign of a medial furrow. The third was a slab, measuring about 11 by 5 inches and $1\frac{1}{2}$ inches thick, of a brownish quartzite, passing quickly on one side into a green argillite, the other side being thickly studded with dome-like eminences about an inch in diameter and nearly half this in height. Most of them show a slight 'dimple' at the top, and a very slight 'step' or swelling often forms a sort of ring part way up the dome. Some argillite, like that on the other side, remains about their bases, and a few tracks of *Planolites* wind among them, and once or twice seem to pass over them. The domes are formed of a quartzite, identical with that of the slab. It shows a very faint stratification, and consists of grains of quartz, not seldom well rounded, embedded in a minutely micaceous matrix, probably an alteration product of felspar. They cannot be concretions; so the speaker regarded them as the casts of pits in the argillite, made by a large annelid, which retreated into it vertically (? *Scolithus*), afterwards filled up by a layer of sand.

The following communications were read:—

1. "The Age of the principal Lake-Basins between the Jura and the Alps." By Charles S. Du Riche Preller, M.A., Ph.D., A.M.I.C.E., M.I.E.E., F.R.S.E., F.G.S.

(1) In a paper read before the Society last session, the author showed, on the evidence of extensive high-level deposits of Deckenschotter in Subalpine France and Switzerland, that the principal Swiss lake-basins could not have existed at the time when those deposits were formed, during and after the first or Pliocene glaciation of the Alps. In the present paper he deals with the question reserved in the preceding one, that is, to which subsequent period the formation of those lake-basins should be assigned. By the light of further

recent investigations in the different localities, he first considers the conditions of the Zurich lake-valley, where the successive glacial and fluviatile deposits are clearly defined, and then applies his conclusions to the other principal lake-basins lying in the same zone along the edge of the Alps.

(2) The hitherto generally accepted view that the lake-basins are pre-Glacial in the old sense, or were formed during the first inter-Glacial period, rests, in the main, on two arguments: (1) that the alluvia at the lower ends of the lakes are all Glacial, not only from their appearance, but because the materials composing them could only have been transported thence by glaciers, which either passed over the lakes by bridging them, or through them by completely filling them with ice; and (2) that the zonal bending of the Molasse along the edge of the Alps, to which the lake-basins owe their existence, occurred before the second or maximum glaciation, because at a point in the Lorze ravine (near the Lake of Zug) the Deckenschotter conglomerate dips reversely, that is, up the valley, while the overlying, younger, loose gravel dips in the opposite direction.

(3) The author adduces evidence to show that the deep-level gravel-beds in the Limmat Valley near and below Zurich are essentially fluviatile, composed of the characteristic Alpine material of the Rhine and Linth drainage areas, and in all other respects similar to the gravel carried by the River Sihl at the present day. These gravel-beds rest upon Glacial clay of the second glaciation, which fills the Molasse-bed of the valley to a great depth, and are overlain by the moraine-bars and secondary products of the third glaciation, the latter being overlain by and mixed with the post-Glacial alluvia of the Sihl.

(4) He further argues that it is, on mechanical grounds, difficult to conceive how glaciers could either bridge, or completely fill with ice, such extensive basins as those of the principal Alpine lakes, from 2 to 8 miles in width and from 470 to 1,020 feet in depth, the quantity of water to be displaced and expelled in the individual cases ranging from 3,500 million to 90,000 million cubic metres or tons.

(5) As regards the more recently enunciated argument of the Deckenschotter and overlying gravel exposure in the Lorze Valley, the author points out that, apart from the difficulty of differentiating the second and third glaciation materials in that locality, it is obviously hazardous to deduce from a purely local phenomenon of this kind, and more especially from any dip of loose gravel—in contrast with rock or compact conglomerate—the date of the zonal bending affecting six valley systems, and extending over more than 200 miles along the edge of the Alps.

(6) The author's investigations point to the conclusion that the deep-level Limmat gravel-beds, overlain by the moraine-bars of the third glaciation, were deposited by a river during the second inter-Glacial period; that the lowering of the valley floor was initiated in the course of the third glaciation, probably when the

glacier had already reached its maximum extension, about 10 miles below Zurich; that the zonal subsidence continued throughout the retreat of the ice; and that the simultaneous formation of the lake-basin should therefore be assigned to the end of the Glacial Period, after which the original basin was, notably at its upper end, restricted to its present dimensions by post-Glacial alluvia.

(7) In conclusion, the author shows that the same arguments apply, in the main, also to the origin and age of the other principal zonal lake-basins, which he illustrates by longitudinal sections. In his view, the position and depth of these basins, as well as the intervening ground, point to the probability that the bending took place not only along one line, but along several, more or less parallel, not always continuous lines within the zone between the Alps and the Jura; that the bending was by no means of uniform depth; and that, therefore, the Alps did not subside as a rigid mass, but that the zonal bending along their edge merely extended locally for some distance from the deepest points of the lake-basins along the floors of the principal Alpine river valleys.

2. "On a Shelly Boulder-Clay in the so-called Palagonite Formation of Iceland." By Helgi Pjetursson, Cand. Sci. Nat. (Communicated by Prof. W. W. Watts, M.A., M.Sc., Sec. G.S.)

There is no equivalent in the Tertiary basalt plateaux of Britain of the great palagonite formation of Iceland, which Prof. Thoroddsen has shown to be younger than the basalt formation of the latter island. The basement layer of the breccia formation, resting directly upon the basalts, contains glaciated blocks of all sizes, up to 6 feet and more in diameter. These ground-moraines are followed by tufaceous sandstones, conglomerate, columnar basalts, other ground-moraines, and volcanic tuffs and breccias. At Birlandshöfdi a shelly Boulder-clay, 70 to 80 feet thick, rests upon the fundamental basalt, which here shows a glaciated surface. Unbroken shells are very rare. *Astarte borealis* is the most common shell, and *Saxicava arctica* and *Mya truncata* are less common, indicating that some of the older moraines are of Pleistocene age. The author concludes that volcanic activity did not pause in Iceland during the Glacial Period, but that it was especially active at the beginning and the close of glaciation, building up bulky hills of slags and ashes, some of which have survived the Glacial Period as volcanoes, while others have become extinct. Volcanic activity had died out in Britain at this time, and hence the palagonite formation is unrepresented in that country.

II.—May 13th, 1903.—Edwin Tulley Newton, Esq., F.R.S., Vice-President, in the Chair. The following communications were read:—

1. "On some Disturbances in the Chalk near Royston (Hertfordshire)." By Horace Bolingbroke Woodward, Esq., F.R.S., F.G.S.

A 'line of flexure' is marked on the Geological Survey map from Therfield, south-west of Royston, in Hertfordshire, to near Heydon

in Cambridgeshire, a curved line a little below the crest of the Upper Chalk escarpment. The author in 1902 found evidence which satisfied him that the disturbances, previously supposed to be an anticline, were due to glacial action, a view confirmed during the present year. Four sections are described: Great Chishall, Pinner's Cross, the Limekiln south-west of Newsell's Park and north of Barkway, and north of Reed. The disturbed Chalk near Royston, with its fractured and displaced flints, occurs in conjunction with Boulder-clay, and the latter is found beneath a considerable thickness of disturbed Chalk. This is compared with similar phenomena near Trimingham, and at Litcham in Western Norfolk. While Boulder-clay occurs along the high ground bounding the disturbed area to the south, the vale and undulating downs immediately to the north are devoid of this Glacial Drift. The facts were to be explained, on the land-ice theory, if the ice were at first welded to the rubbly surface strata in regions north of the escarpment, and, when movement set in, there were overthrusts of débris-laden ice, and upper layers of ice were rent asunder from and moved over lower ones; while to the thrust or long-continued pressure of ice along shear-planes at the higher levels may be attributed the belt of disturbed strata. Certain patches of esker-like gravel in Wardington Bottom might be explained by streams due to the melting of the ice banked up against the scarp; and we might go some way with Sedgwick in believing that the outlines of the combes "do not appear to have been produced by a long-continued and slow process of erosion; but rather to have been cleanly swept out by rapidly descending water-floods."

2. "On a Section at Cowley, near Cheltenham, and its bearing upon the Interpretation of the Bajocian Denudation." By Linsdall Richardson, Esq., F.G.S.

According to Mr. Buckman's map, published in 1901, the Upper *Trigonia* Grit should have been seen at this spot to rest directly, and non-sequentially, upon the Upper Freestone, whereas observation shows the intervention of at least the *Buckmani* Grit, part of which thins out from 4 inches at the north-eastern end to nothing at the other end of the quarry, which is in the direction of the anticlinal axis. The error is not one of fact, but of inference, and the present evidence rectifies portions of those limits which were drawn theoretically. A section near the "Air Balloon" Inn, on the road from Birdlip to Cheltenham, shows the Lower *Trigonia* Grit covered by *Buckmani* Grit and underlain by the Upper Freestone. There is only one section where the Upper *Trigonia* Grit is seen to rest directly upon the Lower *Trigonia* Grit, the latter being only 3 feet 2 inches thick. The causes producing the Bajocian denudation appear to have been forces so acting as to effect a repetition of flexure along old lines of weakness (Aalenian); and thus in the Birdlip area an anticline may be again located, but the elevation was this time much greater: indeed, the level of the Aalenian denudation was passed by the Bajocian. Other sections near Brimpsfield and

in Cranham Wood are given in connection with the location of the anticlinal axis. The exact location of the anticlines and synclines of the Inferior Oolite rocks in the Cotteswolds, where sections are numerous, may afford some important working hypothesis for unravelling the structure of the Vale of Gloucester, where excavations are few.

3. "Description of a Species of *Heterastræa* from the Lower Rhætic of Gloucestershire." By Robert F. Tomes, Esq., F.G.S.

The specimen described was obtained by Mr. L. Richardson from Lower Rhætic beds at Deerhurst (Gloucestershire). It occurred a little way above the bone-bed; it is specifically and generically new to the Rhætic, and it displays Jurassic relationships. It differs from the several Liassic species in the small size of the corallum and of its calices. Remarks on some other Madreporaria from the Rhætic and from the basement of the Lower Lias are appended. It has always been the author's opinion that the Sutton Stone containing Rhætic Madreporaria should be classed as Rhætic; indeed, he believes that it is really Upper Rhætic; and in view of the very close affinity of its organisms with those of the Lower Jurassic, and bearing in mind the great importance of the Ammonite zones as a means of classification of the Liassic deposits, he asks whether the zone of *Ammonites planorbis* should not be taken as the bottom of the Lias.

III.—Mineralogical Society, March 24th.—Dr. Hugo Müller, F.R.S., President, in the chair. Dr. A. Hutchinson described some remarkably interesting experiments which he had made on the diathermancy of antimonite. A cleavage flake of antimonite 0·29 mm. thick and 20 sq. mm. in area, perfectly opaque to light, was placed between cross nicols and exposed to the radiation from a limelight. The plate was somewhat transparent to radiant heat, and the amount transmitted was measured by Boys' radiomicrometer. No heat was transmitted when the planes of symmetry of the crystal coincided with the planes of polarisation of the nicols, but the maximum effect was produced on the radiomicrometer when the plate was turned through 45° in its own plane. The results so far arrived at are in harmony with the orthorhombic symmetry attributed to antimonite. Mr. J. B. Scrivenor described the occurrence of magnetite in the Upper Bunter Sands at Hinksford, near Stourbridge, and of anatase in the Trias of the Midlands. The crystals of magnetite, measuring on an average ·067 mm., were in cubes or octahedra. The mode of occurrence and the presence of a single set of striations parallel to the cube edge, suggest that they are pseudomorphous after iron pyrites. The anatase, in crystals from ·025 to ·06 mm., is found more abundantly in the Keuper than in the Bunter. The crystals show the forms (111) and (001), and according to the predominance of either form are pyramidal or tabular in habit. Many of them are attached to leucoxene derived from ilmenite or sphene. The anatase has been formed *in sitû*, after the deposition of the sandstone, as

a decomposition product of other titaniferous minerals. Professor W. J. Lewis described a large crystal of sartorite from the Binnenthal measuring $4'' \times 1'' \times \frac{1}{3}''$. An analysis by Mr. Jackson gave the following result: Pb = 42·93, S = 25·32, As = 31·11. Professor Lewis also discussed some peculiar twinned crystals of copper-pyrites and cerussite. Mr. W. B. Giles contributed notes on Howlite and other borosilicates from the Borate mines of California. One of these, for which the author proposes a new name, is a white amorphous mineral resembling in appearance pandermite; the results of two closely agreeing analyses of material from different localities corresponded to a formula $8\ CaO . 5\ B_2O_3 . 6\ SiO_2 . 6\ H_2O$. Mr. Giles also described a tantalite from Green Bushes, West Australia, which contained 85 per cent. of tantalic with very little niobic acid. Mr. J. Allen Howe exhibited specimens of peculiar pseudo-stalactitic growths of calcite from the North of England.

CORRESPONDENCE.

THE ZONE OF *MICRASTER PRÆCURSOR*.

Sir,—On pp. 51 and 54 of "The Geology of the country around Salisbury" (Mem. Geol. Surv., Sheet 298) the term 'zone of *Micraster præcursor*' is used. As one who is not a little interested in the genus *Micraster*, and more especially perhaps in the group-form which is known as *Micraster præcursor*, I would crave a little information as to the reasons which have guided the author of this memoir in finding a new zonal title.

Possibly the use of this urchin as a name-fossil is not new, and in that case I must plead guilty to having failed to notice the first occasion of its use. If, on the other hand, this be the first publication in which it has been employed, it would not be unreasonable to expect some statement concerning a fortunately rare event—the adoption of a new name-fossil for one of the zones of the White Chalk.

Arthur Rowe.

1, Cecil Street, Margate.
May 6th, 1903.

SAND-DRIFTING AND SEDIMENTATION.

Sir,—I have read Professor Blake's papers on sedimentary deposits with much interest. So far as I can judge, my election to the General Committee of the British Association in 1879 was due chiefly to my work on this subject, and especially to a paper published in 1878, "Notes on Torbay." Such being the case I very naturally made several attempts to elicit discussion in Section C; but at that time geologists absolutely refused to look at the subject. In 1886 I made a number of special experiments, but the Committee of Section C at Birmingham not only omitted even to include my paper ("Deposition and Denudation, etc.") in the list for reading which was published at that meeting, but for the first time omitted my name from the Committee. Ultimately an influential friend remedied both defects, and I was able to read a six minutes abstract in the subsection on

the Wednesday morning. This enabled me to get a page of abstract into the Report. The double rebuff was too marked to be mistaken. I found the repugnance to the subject as strong at the Geological Society as at the British Association, and with much regret was forced to drop it. At the time I had a yacht, an experimental tank, a moorland river, and a mill leat; and all the experts whose opinion was of value were favourably disposed towards my work, including Sir G. G. Stokes, Lord Rayleigh, Dr. Sorby, and Mr. Gwyn Jeffreys.

At the Bradford meeting, in 1900, I was interested to hear Dr. Vaughan Cornish state publicly from the platform of Section C that he had only tripped me up once. And that happened to be a quotation and an ambiguously worded passage. It was a trip more than a stumble.

I am not at all surprised at the opposition I encountered in petrological work. That was simply a case of amateur methods of research *versus* professorial. But the opposition to my work on the subject for which I was elected to the General Committee, and which my judges were scarcely qualified to condemn, I have never in the least understood. The standing difficulty is this, that some of the most important textbooks are misleading, and, indeed, I very really hear anyone touch on the subject without their running foul of first principles. In 1882 I submitted a paper to the Royal Society on Ripple-mark. It was officially suggested to me that I had not considered Dr. Sorby's work. Well, Dr. Sorby had supplied me with a sheaf of his reprints, and I did not want to appear to be criticising his observations on 'ripple-drift,' when I was investigating another cause of ripple-mark, viz. wave-action. There are three great principles which have to be considered, viz.: (1) the *drifting* of sand by rivers and currents, as studied by Dr. Sorby; (2) the conveyance of sediment in *suspension*; (3) the disturbance of the already *deposited* sediment by waves of different sorts; and (4) the *redistribution* of this sediment by a great variety of currents. I rejoice to see Professor Blake's papers, as they show that geologists are now alive to the great importance of this subject, a subject which is illustrated by every fragment of sedimentary rock cracked under the geologist's hammer.

It is scarcely worth while to refer to my own writings, as they are fragmentary and scattered almost beyond my own knowledge. I found that if I had got hold of a really important fact, that was just the fact which, being unorthodox, would fail to get into print. I happened to have the monopoly of a new source of information, an experimental tank; so my various judges were sceptical, and my judges were all-powerful.

A. R. Hunt.

OBITUARY.

WILLIAM TALBOT AVELINE, F.G.S.

Born 1822. Died May 12, 1903.

The death of W. T. Aveline, at the age of 81, has removed one of the earliest field-geologists attached to the staff of the Geological

Survey under De la Beche. He was appointed an Assistant Geologist in 1840, and after working for a short time in Somerset on the Mendip Hills, he was transferred to South Wales, and surveyed parts of Pembrokeshire. Thence he worked through other counties into North Wales, across the borders into various portions of the West of England, and into the Midland counties as far as Nottingham.

In 1867 Mr. Aveline was appointed District Surveyor to take charge of the mapping of the Lake District, and he resided at Kendal until his retirement in 1882, when he went to live at Wrington in Somerset.

All formations, from the very oldest up to the Eocene, came from time to time under notice, but his chief work was among the Silurian and older rocks. Although painstaking and accurate in his mapping, he went but little beyond the actual survey of the ground. He entered neither into the petrology nor palæontology of the rocks; nor was he given to writing. The maps and sections of the Geological Survey form the chief monument of his labours; and it was in recognition of these, that he was awarded the Murchison Medal in 1894 by the Council of the Geological Society. His portrait will be found in Sir Archibald Geikie's Memoir of Sir A. C. Ramsay (1895).

The following is a list of his published memoirs and papers:—

GEOLOGICAL SURVEY MEMOIRS.

1858. "Geology of parts of Wiltshire and Gloucestershire." (With Ramsay and Hull.)
1860. "Geology of part of Northamptonshire."
1861. "Geology of parts of Northamptonshire and Warwickshire."
1861. "Geology of the country around Nottingham." 2nd ed., 1880.
1861. "Geology of parts of Nottinghamshire and Derbyshire." 2nd ed., 1879.
1863. "Geology of part of Leicestershire." (With Howell.)
1872. "Geology of the country around Kendal, Sedbergh, Bowness, and Tebay." (With Hughes.) 2nd ed., revised by Strahan, 1888.
1872. "Geology of the neighbourhood of Kirkby Lonsdale and Kendal." (With Hughes and Tiddeman.)
1873. "Geology of the southern part of the Furness District in North Lancashire."
1880. "Geology of parts of Nottinghamshire, Yorkshire, and Derbyshire."

OTHER WORKS.

1848. "Sketch of the Structure of parts of North and South Wales" (with Ramsay): Quart. Journ. Geol. Soc., vol. iv, p. 294.
1854. "On the 'Caradoc Sandstone' of Shropshire" (with Salter): ibid., vol. x, p. 62.
1866. "The Longmynd and its Valleys" (letter): GEOL. MAG., Dec. I, Vol. III, p. 279.
1869. "On the Relation of the Porphyry Series to the Skiddaw Slates in the Lake District" (letter): ibid., Dec. I, Vol. VI, p. 382.
1872. "On the Continuity and Breaks between the various Divisions of the Silurian Strata in the Lake District": ibid., Dec. I, Vol. IX, p. 441.
1876. "Absence of the Llandovery Rocks in the Lake District" (letter): ibid., Dec. II, Vol. III, p. 282.
1876. "The Silurian Rocks of the Lake District" (letter): ibid., p. 376.
1876. "The Graptolitic Mudstones of the Lake District" (letter): ibid., p. 527.
1877. "The Magnesian Limestone and New Red Sandstone in the neighbourhood of Nottingham": ibid., Dec. II, Vol. IV, p. 155.
1877. "The Relation of the Permian to the Trias" (letter): ibid., p. 380.
1893. "The St. Bees Sandstone" (letter): ibid., Dec. III, Vol. X, p. 87.
1899. "Geology of the country around Carlisle" (letter): ibid., Dec. IV, Vol. VI, p. 335.

MISCELLANEOUS

Mr. C. L. Griesbach, C.I.E., F.G.S., Director of the Geological Survey of India.

The occasion of the retirement of Mr. C. Ludolf Griesbach, C.I.E., F.G.S., etc., from the post of Director of the Geological Survey of India, which took place on February 24th, 1903, enables one appropriately to refer to his past services in the cause of geological science.

Mr. C. L. Griesbach belongs to an old Hanoverian family, and his grandfather settled in England in the time of H.M. King George III. Most of his family were celebrated as musicians; one of his uncles, the Rev. W. R. Griesbach, held a church living in Yorkshire, and was interested in geology. In his early life Mr. Griesbach's family resided in Austria, and as a young man he joined the Geological Survey in Vienna, and became by that means an excellent field geologist and palæontologist. He was also an accomplished artist. In 1869 he was chosen to join a German expedition to explore the then but little known region of Portuguese East Africa. After enduring with the members of the expedition many hardships, owing to the loss of their ship, and from fever at Delagoa Bay and on the Zambezi, Mr. Griesbach returned to Europe. He published in Vienna, in 1870, "Geologischer Durchschnitt durch Süd-Africa" (Jahrb. geol. Reichs., xx, p. 501); and in the year following, when he came to London, a memoir "On the Geology of Natal in South Africa" (see Quart. Journ. Geol. Soc., 1871, vol. xxvii, pp. 53–71, pls. ii and iii, with 5 text illustrations, a folding coloured geological map of Natal, and a double plate of fossils).

After seven years' residence in London, during which he was engaged in scientific work and drawing, he was, upon the recommendation of Professor Sir Richard Owen, K.C.B., and Dr. Henry Woodward, F.R.S., appointed 26th September, 1878, by the India Office in London, to be an Assistant Superintendent to the Geological Survey of India, and joined in Calcutta the same year. He passed through various grades of promotion in each year from 1880 to 1884.

From November, 1884, to October, 1886, Mr. Griesbach was employed on the Afghan Boundary Commission, with the grade of Deputy Superintendent, and advanced to first grade Superintendent November, 1886. He was created a Companion of the Indian Empire in February, 1887. From 14th January, 1888, to 22nd July, 1889, his services were placed at the disposal of His Highness the Amir of Kabul, made a Superintendent in June, 1889, and became Director of the Geological Survey of India 17th July, 1894, on the retirement of Dr. William King, F.G.S.

When resident in London, Mr. Griesbach served for some years as an officer in the Royal London Militia, now the 6th Battalion Royal Fusiliers, and has since been retired with the rank of Lieut.-Colonel. During his residence in India he was employed on the following War Services, viz. :—